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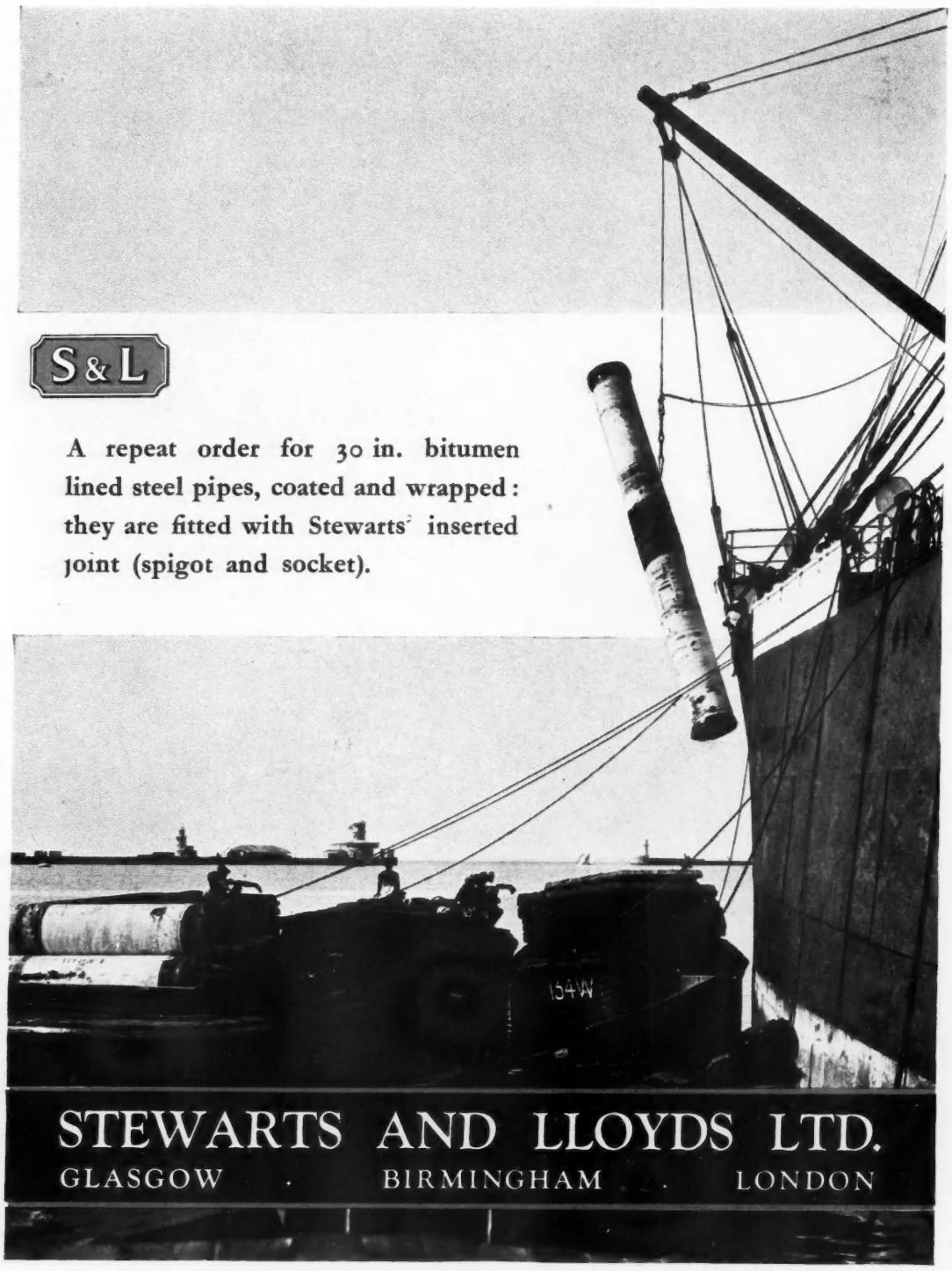

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French Railway Accident.

THE accident that occurred to the Pyrenees-Côte d'Azur express at 1.30 on Sunday morning last, when passing through the station at Marcheprime, a small town about 14 miles from Bordeaux, was caused by the breakage of a coach tire. Only five weeks previously a similar disaster overtook a train on the same line at Saint-Loubès, when five persons were killed and fifty injured. On Sunday the loss of three lives, with ten injured, was not so serious, but that may be explained by the small number of passengers carried on the train. The electric train, consisting of fifteen metallic coaches, had left Bordeaux for Paris in pouring rain, and when approaching the Marcheprime Station at the normal speed of 67 miles an hour the fourth coach left the rails and ploughed through the ballast. The coupling between the third and fourth coach broke. The latter coach smashed against the concrete bed of a standard carrying the cables, which were brought down. The following coaches turned over, except the last three. The breakage of the tire was diagnosed by one of the company's engineers who was travelling in the fourth coach. He pulled the alarm signal at the moment the disaster occurred. Four broken parts of the tire were afterwards picked up. There have been several accidents through broken tires, mostly of a minor character, and the matter has been inquired into for a long time past with the idea of ascertaining whether the trouble arises from tire defects or from more arduous conditions of running, with heavier rolling stock and a general acceleration of train speeds. The fact that the accident at Saint-Loubès happened to an ordinary train with wooden coaches seems to rule out those conditions as a primary cause of tire breakage, and the P.O.-Midi Company affirms that the Saint-Loubès disaster was the result of defective tire metal. An examination of the broken tire at Marcheprime will show whether the same explanation can be offered. The difficulty of releasing injured passengers from wrecked metallic coaches was again demonstrated by the necessity of cutting away panels with an oxy-acetylene jet, which entailed so much loss of time in getting the apparatus to the scene of the disaster, and then into operation, that one sufferer died before he could be extricated.

The Late Mr. H. R. Kempe.

WE learn with deep regret of the death of Mr. H. R. Kempe, the founder of "Kempe's Engineers' Year Book." Mr. Kempe was eighty-three years of age, and he died on Wednesday, April 10th, at his home at Brockham. He was educated at Westminster School and at King's College, London, and was for some years closely associated with the late Sir Charles Wheatstone and other pioneers of electric telegraphy. In 1871 he joined the Engineering Branch of the Postal Telegraph Service, and during his forty-two years of service occupied many important positions, becoming the Principal Technical Officer and Electrician in the Engineer-in-Chief's Office at the General Post Office, London, from which post he retired in 1913. He was closely associated with many improvements in the Post Office telegraph and telephone services, and he it was who introduced and extended the pneumatic tubes used so extensively in handling letters. He designed the submarine cable system between Dover and Calais for the London-Paris telephone service. It was during these busy years that he completed the first edition of the "Engineers' Year Book," published in January, 1894, in which work he was assisted by Mr. H. Hartnell, a colleague in the Engineer-in-Chief's office. In 1930 the "Year Book," then in its thirty-seventh edition, was purchased by Morgan Brothers (Publishers), Ltd., the proprietors of THE ENGINEER. During the war he served as an examiner to the Inventions Committee of the Air Ministry. He was a member of the Institutions of Civil, Mechanical, and Electrical Engineers.

The Big Ship Policy.

A SUCCESSFUL future for the very large liner in the North Atlantic trade was predicted by Monsieur Pierre de Malglaive, in a statement made to representatives of British technical journals on the occasion of last week's visit to the "Normandie" at St. Nazaire. In his opinion, Monsieur de Malglaive said, it was only the big ship which could give speed and comfort in sea travel. In America ships of 30,000 tons, with speeds up to 28 knots, were advocated, but he did not think such ships would be comfortable for the passengers in heavy weather. Again, on the question of economy in working, large ships were better than smaller vessels. He had recently investigated the tonnage necessary to carry annually some million passengers across the North Atlantic, and had found that while that could be done quite easily by about ten ships having the size of the "Normandie" or "Queen Mary," at least thirty ships of the 30,000-ton type with speeds of from 22 to 23 knots would be needed for the same work. The Atlantic Conference figures for 1927 showed that Atlantic liners had in that year to make some 2000 crossings in order to carry about 600,000 passengers. Such an arrangement was, he considered, a tremendous waste of travelling capacity. At the present moment all the shipping companies engaged in the North Atlantic trade were going through a very difficult time. Was the time not more than ripe, he asked, for some kind of agreement between Great Britain, France, Germany, and America to be made, so that by rationalising the respective services there was some possibility of making a margin of profit? When six years ago the French Line decided to order a new vessel, there were many who had advocated a 30,000-ton ship, but the very large ship which he had consistently fought for won the day, and the "Normandie" was laid down. It was to be noted that the Cunard Company came to the same conclusion, and decided to build the "Queen Mary." The future of the Atlantic passenger trade lay, in his opinion, undoubtedly with these very large liners.

Honours for Aswan Dam Contractors.

THE announcement is made that King Fuad, of Egypt, has honoured Topham Jones and Railton, Ltd., of London, who were the contractors for the recently completed second heightening of the Aswan Dam. On their governing director, Sir Evan Davies Jones, he has conferred the Order of the Nile, 2nd Class. On Mr. H. Croft, a director, and Mr. Bell, the resident engineer, he has conferred the 3rd Class of the same Order, while Mr. David Miles, the works manager, and Mr. A. Macdonald receive the 4th Class of this Order. The alteration, which was carried out to the designs and under the direction of Sir Murdoch Macdonald and Partners, of Westminster, the consulting engineers to the Egyptian Government, was fully described and illustrated in THE ENGINEER of June 2nd, 1933. It will be recalled that the dam was to be raised in height by 9 m. over a length of 1¼ miles, an enlargement which doubled the storage capacity, increasing it by 5000 million cubic metres. This undertaking, which necessitated the employment of 6000 men under exceedingly trying weather conditions, was completed most expeditiously and economically. The cost of the work amounted to about £E4,000,000. This works out per cubic metre of water stored at less than the corresponding figure for the dam as originally constructed. The whole of the work has been carried out under the supervision of H.E. Mohamed Pasha Shafig, the Minister of Public Works; Abd-el-Megid Bey Omar, Director-General of Reservoirs; and Ahmed Bey Khairy, the resident engineer in charge.

Accident to the "Graf Zeppelin."

IT is reported from Pernambuco that the airship "Graf Zeppelin," while mooring on Friday, April 12th, fouled a house near the aerodrome, slightly damaging her engines and envelope. In the course of her 1200-mile trip from Rio de Janeiro she experienced bad weather and when attempting to pick up her mooring the weight of rain on the envelope brought her head too low. The commander swung her about, discharging her forward ballast at the same time, when, owing to a sudden gust of wind, the airship moved broadside on and fouled a housetop. After tearing through the roof and part of one wall the "Zeppelin" uprooted some trees. She was finally brought to her mooring about an hour and a-half later. The damage to the airship consisted of several holes in the lower part of the envelope, injury to two engines, and the loss of one propeller. Repair work was immediately begun under the supervision of the airship's own officers. During her seven years' life the "Graf Zeppelin" has covered over 621,000 miles in 10,000 flying hours and has made ninety Atlantic crossings. All told, she has made 423 flights and has carried 27,000 passengers, 5,500,000 postal packages, and over 40 tons of freight.

The Late Mr. John Crocker.

MANY of our readers associated with naval engineering will learn with regret of the death on Monday last of Mr. John Crocker, late Headmaster of the Royal Naval Engineering College, Keyham. He died at his home, 19, Lockyer-road, Plymouth, within a few weeks of his eighty-fourth birthday. Nearly seventy years ago he became one of the early engineer students of the Royal Navy, and served for a short while afloat as an engineer officer. His last sea service was in H.M.S. "Shearwater," the surveying vessel on the East Coast of Africa in 1874. On his return to England he accepted an offer to transfer to the educational side of the naval service. After short periods at H.M. Dockyard Schools at Sheerness and Devonport, he was selected to become one of the original staff at the opening of the Royal Naval Engineering College, ultimately becoming headmaster. He retired in 1910, when the College temporarily closed, and the old system of training for naval engineer officers was superseded by the Selborne-Fisher scheme of "common entry." John Crocker exercised a considerable influence on those engineer officers and constructive officers who passed through the College training during his thirty years of service there. Although a strict disciplinarian, he earned not only the respect but the affection of large numbers of students, who include many who have risen to the highest positions in the Service, and amongst whom may be mentioned the present Engineer-in-Chief of the Navy, Engineer Vice-Admiral Sir Harold Brown, and the present Director of Naval Construction, Sir Arthur Johns. Mr. Crocker was a member of the Institution of Civil Engineers and the Institution of Mechanical Engineers. In his years of retirement he retained the liveliest interest in matters concerning education and naval engineering, and kept in touch with many of his former students.

Proposed Fuel-Oil Duties.

MR. NEVILLE CHAMBERLAIN, the Chancellor of the Exchequer, introducing the new Budget, said, concerning road vehicles, that many members of Parliament were aware of the recent development in the use of what were known as "Diesel engines," particularly for the heavier types of goods and passenger vehicles. However admirable in itself the development of such engines might be, they did very considerably reduce the very important revenue derived from the duty on light hydrocarbon oils. There were now said to be over 7000 heavy oil-engined vehicles on the roads. It was true that the heavy oil engine with 1 gallon of fuel would do as much work as a petrol engine with a gallon and three-quarters of petrol, but since the duty on heavy oil was only one penny a gallon, whereas the duty on petrol was eightpence, it would seem that an enormous fiscal advantage accrued to the heavy oil engine. Owing to the lack of relationship between the licensing fee and the work done by the vehicle, very little equalising of this came from the imposition of an increased licensing fee in 1933. The total taxation of the heavy oil-engined vehicle doing only a moderate mileage was from one-half to two-thirds of that on the corresponding petrol vehicle. The Chancellor estimated that the Treasury was losing £1,300,000 per annum and if unchecked the loss might well rise to £2,300,000 per annum. Under the circumstances it is proposed to remove the differential licence duty, replacing it by raising the duty on heavy oil used in road vehicles only to eightpence a gallon. As the heavy oil vehicle can use a large range of fuels, it was impossible to tax specified grades. All grades used on the road must therefore be taxed.

The French Liner Normandie.

AT the end of last week we were invited by the French Line to visit the Penhöet Shipyard at St. Nazaire and to inspect under construction the new 79,000-ton turbo-electric liner "Normandie," which, on May 29th, sails from Le Havre on her maiden voyage to New York. The party included representatives of the leading British technical and shipping journals, and was personally conducted by Monsieur Pierre de Malglaive, the resident director of the French Line in London. The Channel was crossed from Newhaven to Dieppe on Thursday evening and the return trip made on Sunday evening. An interesting feature of the journey was the provision by the French State Railways of a new "Bugatti" petrol-driven rail-car, designed for speeds up to 75 m.p.h., which covered the 555 kiloms. between Dieppe and St. Nazaire in less than seven hours and gave the party an excellent opportunity to study the signalling arrangements on French railways and the new colour light systems of signalling now being installed. On arrival at the shipyard Monsieur Coqueret and his technical staff met the party and, together with Monsieur de Malglaive, gave very full information with regard to the construction of the liner and her turbo-electric propelling machinery. The ship is now well advanced and some 7000 men are engaged on her completion. She incorporates new and interesting features in hull design, propelling and auxiliary machinery equipment, the lay-out of passenger accommodation and its decoration, and the provision made for safe navigation and the prevention of fire.

The Grounding of the Aquitania.

ON the afternoon of Wednesday, April 10th, the 45,647-ton Cunard-White Star liner "Aquitania," returning from a Mediterranean cruise, went aground at four o'clock off the Brambles Bank, between Bourne Gat and Calshot Light. There was a heavy sea running with a high wind, and the ship grounded as she was rounding the difficult "S" bend in the deep-water channel. Tugs failed to move her that day, but on Thursday afternoon at 5.7 she came off the mud under her own power, with the assistance of eleven tugs. The Cunard-White Star Company reports that the ship has received no damage whatever, and her sailings will be maintained as planned. The incident, however, serves to remind us of the difficulties in the safe navigation of very large liners in the entrance to Southampton Water, especially under difficult weather and sea conditions. In 1931 three large ships—the "Mauretania," "Berengaria," and "Statendam"—grounded within the space of three weeks. Now that the large 53,000-ton German liners "Bremen" and "Europa" are using the Port of Southampton, and next month the 1000ft., 79,000-ton French liner "Normandie" is to make her first call, the position as regards a safe and easy entrance to Southampton Water is one which, we suggest, calls for the most careful consideration. It has now been decided, with the assistance of shipping firms, to install an appropriate wireless beacon service at the Brambles Bank.

Radiology in the Welding Art.*

By V. E. PULLIN, C.B.E., Director of Radiological Research, Research Dept., Woolwich.

THE science of Radiology has many useful applications in the inspection, examination, and investigation of welding processes.

Intrinsically, of course, the fact that a radiograph reveals internal defects in a metallic structure confers unique value on the method. At the same time, there are practical considerations involved in its use which militate to some extent against its universal employment.

In this country there exists a curious, nevertheless deep-seated, conservatism in industry and a certain reluctance to adopt new methods. It is a striking fact that although the practical pioneer work in industrial and engineering radiology was conceived and carried out in this country, yet now we are very far behind the Continent and America in the general industrial use of the method. Reference to technical advertisements and literature from abroad illustrate how very general radiological methods have become there, not only in the routine examination of welds, but also in general engineering practice. In fact, the American Society of Mechanical Engineers Boiler Construction Code for unfired pressure vessels requires X-ray examination of all welded seams.

Seventy-five miles of steel welds, running up to 3in. in thickness have been X-rayed in the construction of the Boulder Dam in America. This stupendous piece of inspection work involved 159,000 separate X-ray exposures. The economic value of the work obviously is expressed in the assurance of perfection which resulted from the examination.

Delayed failures in engineering materials are no unknown *contretemps*. They sometimes prove to be extremely costly experiences. Therefore, it is a matter for some wonder why the fullest use is not made of the facilities which are available for inspection in spite of the facts that such methods may not yet have reached ultimate perfection, and that their use would add somewhat to production costs.

The reason is that there is a subtle consciousness in the mind of British manufacturers that although their products may contain inherent defects, yet in the ordinary course they will not cause trouble. What the eye does not see the heart does not grieve about. To detect such defects may savour of unnecessary and expensive experiment. Nevertheless, there is no question but that Consulting Engineers, Users, and Customers will very soon insist on the use of radiology in the examination of important structures. Therefore, manufacturers and operatives would be wise to discern the writing on the wall and take steps about the adoption of radiography, which otherwise may be forced upon them at an inconvenient moment.

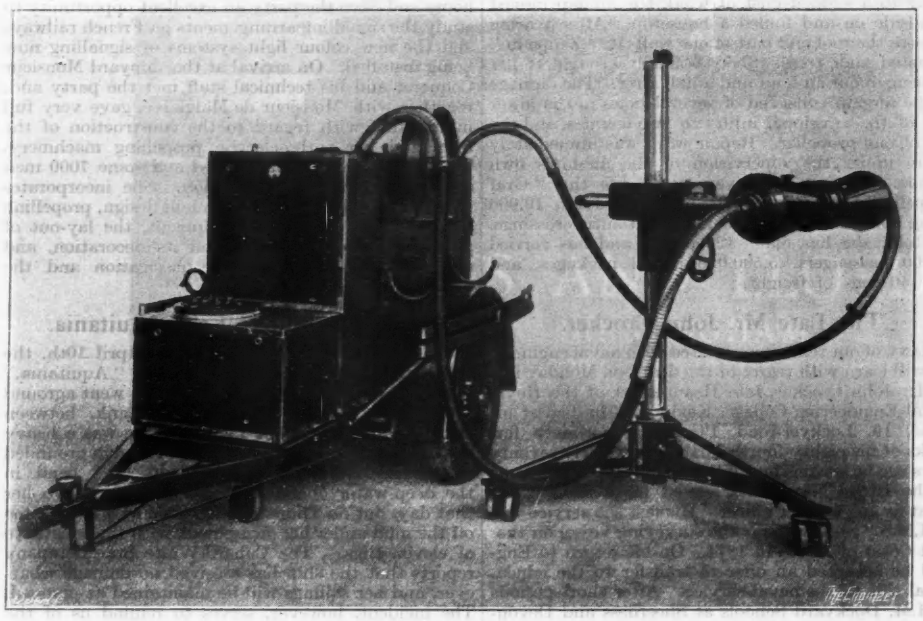


FIG. 26—MOBILE INDUSTRIAL X-RAY OUTFIT

The idea that radiographic examination is always destructive is fallacious. For example, the critical examination of radiographs of welding suggests that large numbers of welds which present an ominous radiographic appearance are really comparatively sound and quite acceptable. On the other hand, a really bad specimen is certainly possible of definite diagnosis.

In the early days of industrial radiology the use of X-rays in any extensive way, or as often as they should have been used, involved grave inconvenience because of the difficulty and expense in transporting specimens to an X-ray laboratory. In fact, it was impossible to move some structures at all. Nowadays, however, this objection is removed. Owing largely to the advent of earthed high-tension cables and the enterprise and ingenuity of manufacturers of apparatus, transportable X-ray sets are obtainable which are both safe and robust, and are also extremely flexible in operation. Fig. 26 is an illustration of a mobile industrial outfit made by Messrs. Philips. Such an apparatus as this is capable of examining steel structures up to a thickness of 2½in. to 3in.

In the Research Department at Woolwich, we have constructed a transportable X-ray laboratory. It is entirely self-contained; 30 yards of earthed high-tension cable connect the X-ray tube with the high-tension transformer, so that we are able to operate the tube in comparatively inaccessible places, such as on board a ship in dock or in a factory or workshop—Fig. 27.

Thus difficulties of transport should no longer offer a serious obstacle in applying X-ray examination, because X-rays may be taken to the job. This is a consideration of the greatest importance in the application to welding inspection.

COSTS.

The question of cost may conceivably act as a deterrent in some cases. In this respect it should be said at the outset that the confidence enjoyed as a result of X-ray examination, together with the saving consequent on the immediate detection of defects, does, in the majority of cases, appreciably outweigh the initial increase in the cost of inspection or construction. Not only that, but the advertising value of X-ray inspection plays no insignificant part in stimulating confidence in the mind of a prospective user.

The capital cost of a complete X-ray equipment suitable for general engineering work is approximately £1200. Apart from the actual X-ray tube, it would be reasonable to calculate depreciation upon a fifteen years' basis.

The life of an X-ray tube is approximately 1000 exposure hours, and the cost of a new tube is £120. Thus if we consider the inspection of a 1in. weld, each exposure covering lengths of 2ft., involving an average exposure of, say, 2 minutes (this is an outside estimate) would enable the cost of the tube to be expressed as 2ft. of weld for 1d.

The cost of power is negligible. An X-ray equipment takes about 4 units per hour. The cost of film is about 1d. per 6 square inches. Nowadays, for a considerable amount of work not demanding very fine detail, it is possible to use sensitised paper instead of film, and if this is done the cost is reduced to half this figure. It is customary to allow about 25 per cent. of the cost of film for development.

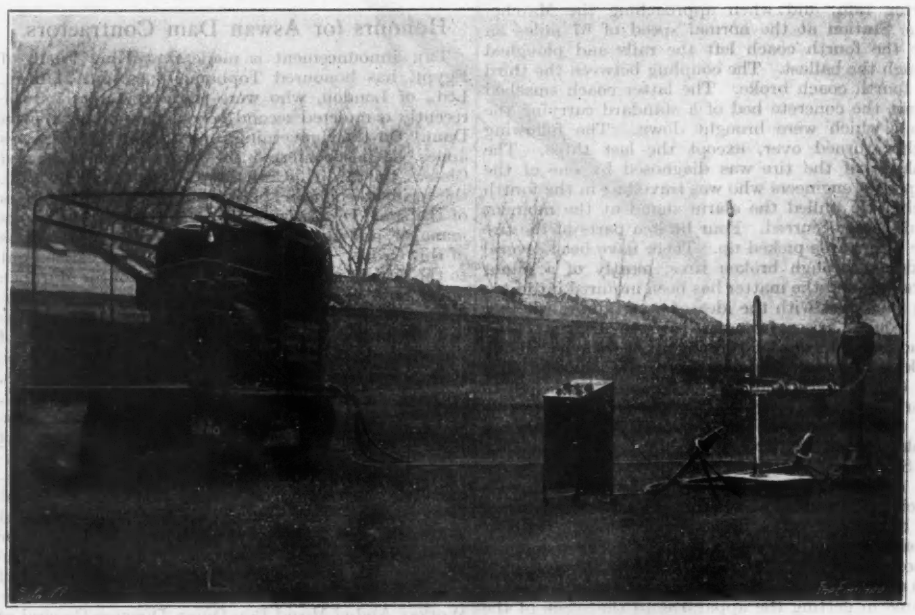


FIG. 27—TRANSPORTABLE X-RAY LABORATORY

LABOUR.

With regard to labour. A mistaken idea is prevalent in some quarters that it is necessary to employ a scientist to operate an X-ray equipment. This is by no means true. The type of man who would appear to be suitable for inspection radiography might be described as a superior laboratory technician. The actual operation of the set presents no difficulties, and the technique involved in the examination of welds can very well be reduced to a routine. This man would require a lower grade assistant to do development and generally to assist. With regard to the interpretation of the films, that is a matter which as far as welding is concerned, we shall deal with in a later part of this article; but it is to be observed that for any particular type of work the interpretation will only vary within certain well-defined limits, and the necessary experience will easily be acquired by the type of man to which we have referred. Some preliminary tuition by an expert would, of course, have great value. Having acquired the necessary experience and confidence in interpretation the responsibilities of the radiographer would be comparable with those of the ordinary engineering assistant inspector.

DANGER.

The question of possible danger to operators and staff is also sometimes regarded as a reason for not adopting X-ray examination. This question has been the subject of a great deal of consideration by an expert international committee. Regulations have been formulated for the guidance of those engaged in X-ray work. They are particularly applicable to the *personnel* of hospitals. On the other hand, the industrial use of radiology is not subject to quite the same dangers. The chief element to be considered in the latter case is the safety, both radiological and electrical, of the X-ray equipment. It may be said at once that reputable and experienced manufacturers of X-ray equipment have now achieved a very high standard of excellence in design and manufacture. The majority of X-ray units on the market are perfectly safe and efficient within the limits and

* Figs. 1 to 25 will be found in the Supplement.

under the conditions defined by the makers. At the same time it is to be emphasised that before purchasing an X-ray equipment the inexperienced prospective buyer would do well to seek expert advice as to the suitability and safety of the proposed unit for the particular purpose for which it is required.

Nature of a Radiograph.

It will be well to reconsider the nature of a radiograph for a moment before we contemplate the application of the method to the examination of welds. We pass a beam of light (X-rays) through a plate of steel or other opaque metal and in the course of its passage it suffers differential absorption in the material. Thus if we passed it through a perfectly homogeneous structure, it would suffer certain general absorption, but it would be uniform ; and if we had a photographic plate so placed on the opposite side of the specimen as to record the emergent beam, it would be uniformly blackened. If, however, there were cavities or cracks in the material, these variations in density would appear as shadows on the photographic plate. A radiograph therefore is a shadow picture. It follows that in order to obtain a useful radiograph, we must pass our beam of rays or light through a specimen in such a way that all significant shadows may be recorded on the photographic plate. Let us see how this circumstance affects the examination of a weld. Suppose we are asked to radiograph a lap weld. Let us refer to Fig. 28 A. We shall detect on our radiograph discontinuities in surface A and surface B—for example,

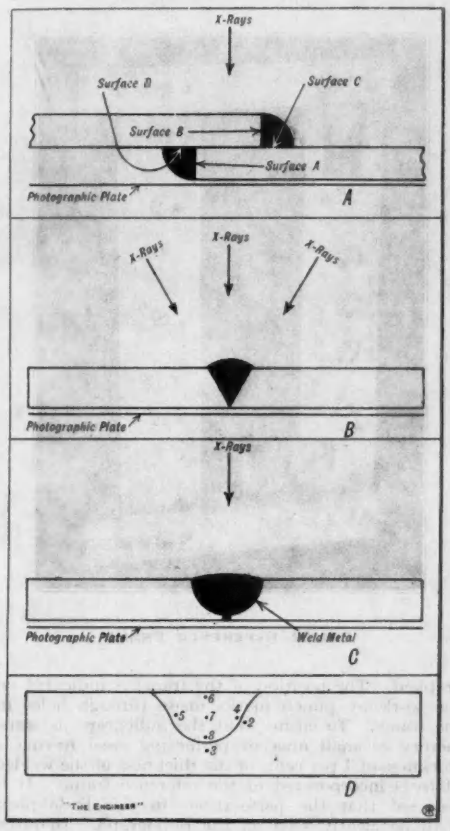


FIG. 28

lack of penetration. We should also see small holes or inclusions in the weld metal. Flaws or lack of penetration in surface D or surface C would not show, unless there was a comparatively large cavity involved, which in practice would probably not be the case. (In fact, X-rays can show a cavity which is about 1 per cent. of the total thickness of the specimen ; that is, if the technique is good.) Therefore it follows at once that X-rays cannot really usefully be employed to examine lap welds. They can only enable us to give a partial opinion of the soundness of the weld. This fact must be accepted. Lap welds do not lend themselves to examination by X-ray, *except in one direction*.

Interpretation.

Now we must consider butt welds. Here the story is quite different. Butt welds are capable of complete X-ray examination, and, if properly interpreted, the results are of very considerable value. In this connection we must remember that very many important welded structures do make use of butt welding. After what has been said concerning the nature of a radiograph, it will be obvious that a butt weld by its nature is peculiarly suited to X-ray examination. Let us refer to Fig. 28 B. Here we may direct our X-rays, if necessary, from three directions. We may shoot them along both surfaces of the vee and also, if we desire, perpendicular to the plate through the weld metal. Thus all significant flaws, including lack of penetration, will be discovered. The illustrations which accompany this article all refer to butt welds in such structures as high-pressure boilers, ship construction, engineering structural welds, and so on.

We will now consider some concrete examples to illustrate the interpretation of weld radiographs. Figs. 1, 2, and 3 on the Supplement to this issue are radiographs of welds similar to those in a high-pressure vessel. The weld section is shown diagrammatically in Fig. 4. It is ½in. plate. The rays were directed perpendicularly through the weld. In Fig. 1 it will be observed that the whole radiograph is spotted. The spots represent small gas and inclusion cavities. In spite of these numerous small cavities, however, the weld may be regarded as being comparatively good. In Fig. 2, in addition to small inclusions, there are two continuous lines corresponding to the junction of the weld and parent metal. These lines suggest some lack of penetration. The weld is an indifferent one. In Fig. 3, while there is no evidence of any lack of penetration, there is one line in the picture centrally placed which indicates that the bottom of the vee has been imperfectly filled with weld metal. The weld is not by any means perfect, but it is better than Fig. 2.

Fig. 15 refers to some 1in. experimental welds. The plates were ½in. wide. In Fig. 15 on the left there are radiographs taken perpendicularly to the weld. The shadows should be noted and compared with the engravings on the right, which show the corresponding radiographs taken laterally through the plate. A_1 was made by a single run of metal by a process known as weaving, while A was done by means of several separate runs of metal. The same remarks apply to B and B_1, C and C_1, D and D_1. In A we see one cavity of importance, in A_1 two cavities. The weld is a good one, as we should have judged from the perpendicular view. In this case the electrode used was a medium-coated one. The operators in each case were experts. In B we find little for comment, except that the bottom of the vee is not filled. In B_1, however, we have very definite evidence of lack of penetration. The weld is a bad one ; again corroborated by the perpendicular view.

A definite line is seen between the parent and the weld metal. In the case of B and B_1 the electrode was a light-coated one. In C and C_1 there are small cavities of comparative unimportance. The weld is comparatively good. In this case the electrode was a very heavily coated one. In D and D_1 we have more small cavities, but no lack of penetration. The weld is comparatively good, but not so good as C. In this case the electrode was a comparatively heavily coated one. On the whole, with the exception of B, which is bad, it appears that the single run welds are better than the multiple run ones, although the difference between the two is not by any means striking. It may be that the temperature was more constant in the welds made by the single run weaving method. This conclusion is supported by an investigation by X-ray spectrum analysis to which reference will be made later.

In the course of a somewhat extensive investigation of the radiological examination of welding, some 120 specially prepared welds were X-rayed and subsequently subjected to tensile tests. They were then carefully dissected to lay open the flaws revealed by the radiographs. One or two examples from this research have been selected for the purpose of this article. Fig. 28 C is a sketch of the form of all the welds used in this research, whatever the thickness of the plate. Two different electrodes were employed in making the welds. They will be referred to as X and Y. In each case the excess metal had been planed off before radiographing. Fig. 17—Supplement—shows the radiographs of seven selected welds. It will be obvious at once that electrode X produces welds characterised by a large number of small gas inclusions, hence their spotty appearance in the radiograph. These welds also show certain definite

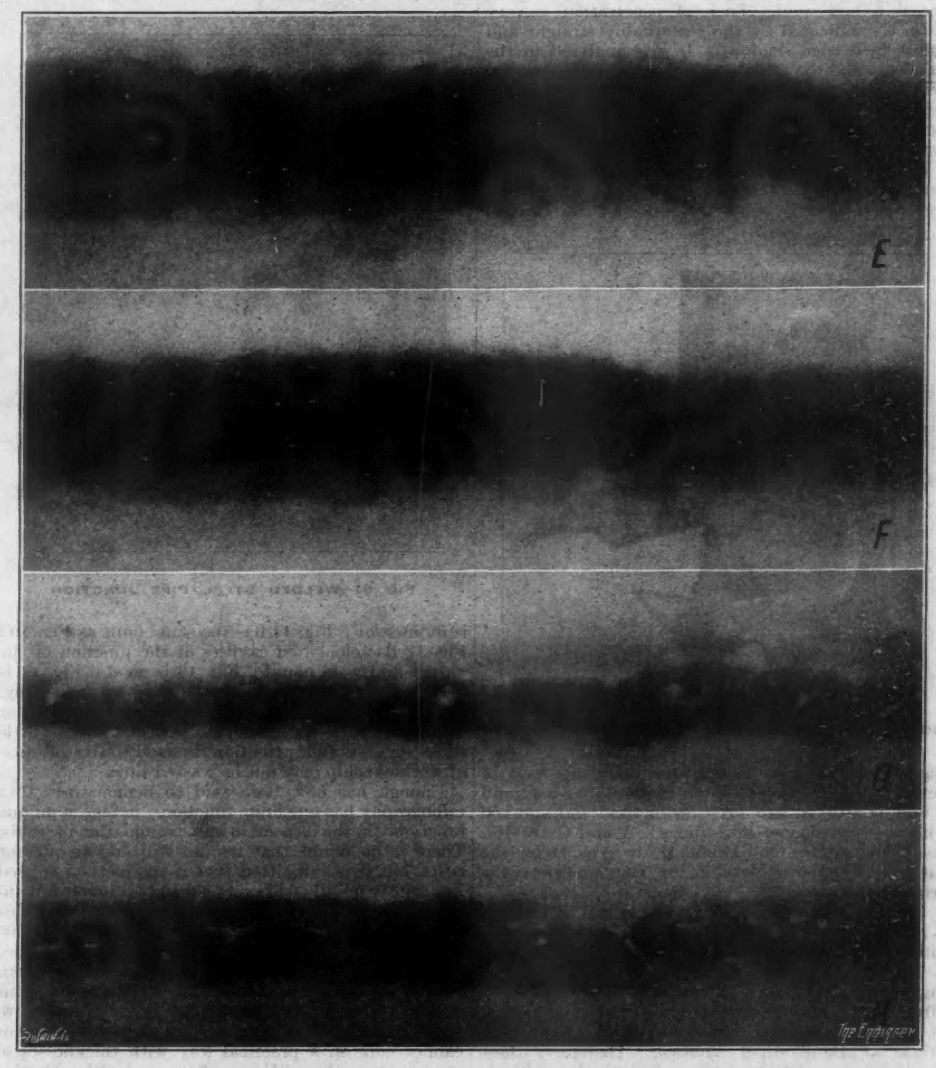


FIG. 29—SEAM WELDS IN SHIP CONSTRUCTION

lines. Electrode Y, on the other hand, produces much cleaner looking welds which are characterised by lines only.

Consider *Weld C* 8. Here we have, in additon to numerous small cavities, a definite indication of two lines at the extreme edge of the weld ; this appearance suggests that penetration is imperfect. Further, a line in the middle of the picture suggests that the space at the bottom of the vee is not filled with weld metal.

Weld C 11.—Very much the same appearance as C 8, but the straight line shadows on the edge indicate lack of penetration.

Weld C 14.—No small holes, but in places there is some evidence of lack of penetration, at the same time the vee is completely filled.

Weld C 20.—Very much the same as C 8, but without the central shadow ; there is some evidence of lack of penetration.

Weld C 21.—No small cavities worth mentioning Along one edge there is definite lack of penetration and a slight suggestion of imperfect filling of the bottom of the vee (partial central shadow).

Weld C 25.—Some small gas cavities. On the whole, however, there is very good penetration.

Weld C 27.—No gas cavities, but in patches there are elongated irregular cavities.

The black lines on the radiographs show where the welds were subsequently cut for examination.

Let us now consider more analytically one or two specimens. For example, C 25.

Fig. 18 is the radiograph, and the black lines indicate where it was cut. After cutting, we had nine separate specimens which were radiographed laterally, the radiographs being shown below. In specimen 9 we see a hole or cavity of non-penetration at the edge of the weld. The same is seen in specimens 6, 7, and 8.

Each of these specimens were then subjected to tensile test and the results are shown in the table. Clearly, therefore, weld C 25 is comparatively a good one. A conclusion we should normally have come to by an examination of the radiograph.

Weld C 27 (Fig. 19) was now treated in exactly the same way, and it will be observed that in this case the tensile tests are even better; therefore, in spite of the somewhat alarming looking lines in the radiograph, the weld is distinctly good; in other words, the lack of penetration is not marked. It is to be observed that there are no small gas cavities in this weld.

Weld C 24, *Electrode X*, $\frac{1}{2}$*in. Plate* (Fig. 20).—From the radiograph our immediate judgment is that this is a bad weld. Lack of penetration is very distinctly indicated by the remarkably straight and well-defined edge shadows. It was analysed in the same way and the table shows that the tensile results were very poor. From the radiograph we diagnose definite lack of penetration, and a reference to the sections, particularly 2, 3, and 4, shows this condition very clearly.

Weld C 24 was subjected to further analysis as illustrated in Fig. 21. The weld was examined at layers progressively below the surface as shown, and

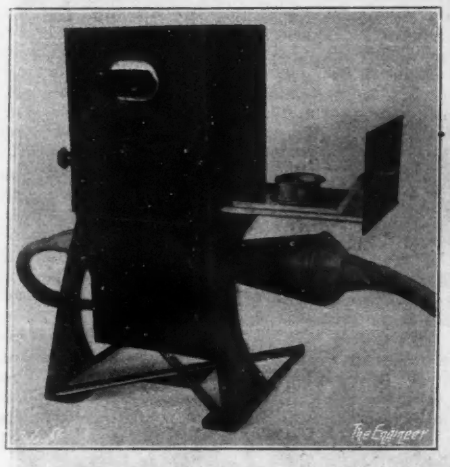


Fig. 30—Visual Apparatus for Aircraft Parts

Fig. 22 shows very clearly the complete lack of penetration. A and B show the weld as cut, and C and D after it had been magnetised and sprayed with a suspension of iron filings. A and C are $\frac{1}{8}$in. below the surface, and B and D are $\frac{3}{16}$in. below the surface. Further analysis in this way confirmed the original diagnosis.

Fig. 23 is a comparison between two $\frac{1}{4}$in. (Electrode X) welds, which serves to bring out the essential difference in the radiographic appearance.

Fig. 16 A is a photograph of sectioned welds showing minute cavities. B are the same specimens after magnetisation and spraying with iron filings. It will be seen that many fine cracks have their origin at these small cavities. Therefore, these characteristic defects are not entirely without dangerous significance, particularly from the point of view of fatigue.

Fig. 5 shows the result of the repair of a crack in a steel cylinder by welding. The visible crack was drilled at each end and then welded. The repair was obviously adequate.

Fig. 7 is a similar case. In this instance, although the weld was apparently a sound one, the radiograph revealed the fact that the bunch of cracks still existed after the alleged repair.

Fig. 8 is yet another similar case; in fact, it was another part of the same cylinder as Fig. 7. In this instance the welded repair was good.

These illustrations are useful in showing how radiology may be valuable in this highly important function of welding.

Fig. 6 shows two radiographs of a welded part of a road vehicle. A is a radiograph of a welded seam; it is not a very good weld. B is a radiograph of the same weld after heavy road trials. It will be observed that the defects in the weld are considerably accentuated. The gap is very much wider.

Fig. 29 are radiographs of seam welds in ship construction. E and F are vertical welds; G and H are horizontal welds. This work was all done by the same welder under the same conditions. The difficulties involved in these two positions are well illustrated by the difference in quality of the weld. The vertical welds are good, but the horizontal ones are poor.

In Fig. 24 A is a radiograph of a thin ($\frac{1}{16}$in.) metal plate in aeroplane construction. The weld is good. B are three welds of thin steel tubes, also in aeroplane construction; here also the welds are good.

It is noteworthy that such welds as these may be examined visually if suitable X-ray apparatus is employed.

Fig. 30 illustrates visual apparatus, specially designed in the Research Department, Woolwich, for visual examinations of aircraft parts. Special attention has been devoted to the consideration of the safety of the operator, and the design is practically foolproof. The image on the fluorescent screen is not viewed directly, but indirectly by means of an inclined mirror.

Fig. 31 is a welded thin steel pipe junction; the weld is bad.

One outstanding use of radiology in welding technique may be mentioned with advantage. It affords an excellent method of testing workmanship. In this respect, too, it has not inconsiderable psychological value. Figs. 9, 10, 11, 12, 13, and 14 are radiographs of welds in $\frac{1}{4}$in. steel plate. They were done by six different welders, each of them being a skilled man. They were done with the same electrodes and under exactly similar conditions. Fig. 9 is not bad; Fig. 10

Fig. 31—Welded Steel Pipe Junction

is indifferent; Fig. 11 has the same fault as Fig. 10; Fig. 12 has elongated cavities at the junction of the parent and weld metal; Fig. 13 is good; Fig. 14 is perfect. The question may at once be asked, Why, if a perfect weld is possible under these particular conditions, are they not all perfect? This little series suggests that attention directed to the question of workmanship may not be wasted time.

Enough has now been said to demonstrate that radiography has a definite function—in fact, a unique function—in the inspection and examination of welds. There is no doubt that its use will add to present costs, but it is submitted that if the method is used judiciously it will yield practical and economic advantages which will more than compensate for this inevitable concomitant. There is one other disadvantage. Not all welds are accessible to X-ray examination. It has already been stated that modern mobile apparatus has gone a long way to remove this difficulty, but at the same time it still remains to some extent. Further, modern X-ray apparatus cannot cope in a practical way with thicknesses of steel greater than 2$\frac{1}{2}$in. to 3in., and although this covers the bulk of every-day requirements, yet there are cases where it is desirable to examine thicker specimens. Radium has been used very largely in the radiographic examination in thick (8in. of steel) and inaccessible examples (*vide* The Engineer, May 6th, 1932, page 492). It forms a very valuable adjunct to X-rays in general non-destructive testing. Radium may be taken on board ship; it may be used in confined spaces, and it requires no constant operation. Radium technique is different from that of X-rays, but at the same time its use has now been developed so that under suitable circumstances it is capable of valuable application in engineering inspection.

It has been recorded that Watertown Arsenal in America has enjoyed considerable improvement in welding technique and quality since the introduction of routine radiological inspection (*Metal Progress*, 1930, Vol. 18, page 68). A considerable amount of similar inspection work is carried out in Germany, largely because of the improvement in technique, stimulated partly, no doubt, by the welder's knowledge that his finished work was capable of non-destructive examination.

One word of warning should be added. Metal radiography demands experience and technique in its practice. It is an easy matter to discredit the method by bad or ignorant operation. It is possible, and of frequent occurrence, that an untrained or careless operator may radiograph a flawed specimen and produce a radiograph free from any suggestion of defect. It follows that some training in operation is essential. This question, however, should present no great difficulty. The scientific basis of metal radiography has been worked out very thoroughly, and tuition in technique is a matter of a very short period, say, one or two weeks, if the pupil is intelligent. Some of the large X-ray apparatus manufacturers are experienced in industrial and engineering work, and are only too pleased to arrange for customers to receive careful and expert instruction.

The question of routine examination of welding by X-rays raises the important question as to how it is to be incorporated in a specification. The contractor must be told exactly the conditions under which the radiography must be done. He must also be told, within certain limits, what radiographic appearance will be accepted and what appearance will involve rejection.

With regard to the first condition, there are two important factors: (1) The radiograph must be positively identified with the particular section to which it refers, and (2) there must be definite evidence that the negative or radiograph is satisfactory from a radiographic point of view, and, consequently, that it is safe to base a conclusion upon its appearance. In order to secure these conditions a method has been worked out in the Research Department, Woolwich.

A reference frame of brass has been constructed which is placed on the section of weld to be radio-

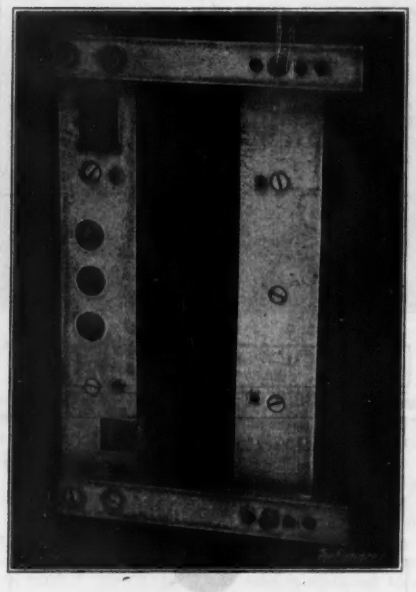


Fig. 32—Reference Frame

graphed. The position of the frame is indicated on the work by punch marks made through holes in the frame. To ensure that the radiograph is satisfactory a small area of perforated steel having a thickness of 1 per cent. of the thickness of the welded plate is incorporated in the reference frame. It is required that the perforations in this little plate shall be clearly seen on the radiograph. In order to be certain that the correct reference frame is used for the actual thickness under examination, a figure indicating the appropriate thickness forms part of the frame. There will be, of course, one frame for each thickness of plate. Different sections of the same piece of work are numbered. The method of ensuring that the number on the radiograph corresponds to the number on the work is simple. A piece of thin sheet lead is slipped into an aperture in the frame, after the frame is in position. The appropriate number is then stamped through the lead into the work. This number is thus recorded on the radiograph in the exact position in which it occurs in the work. Fig. 32 is a photograph of one of these frames. The use of such frames by the contractor would be compulsory.

With regard to any statement of what is to be acceptable and what is not, is a matter for the engineer concerned. The radiographic expert will, in the first place, explain to him the significance of radiographic shadows as I have done in this paper. It is then for the engineer to define his standard of acceptance for incorporation in a specification. Specimen radiographs will, of course, accompany it.

X-Ray Spectrum Analysis.

There is a further application of radiology to the investigation of welding. This involves the use of X-ray spectrum analysis. By its nature, however, this method of investigation is confined to the laboratory. It is not an inspection test in the ordinary sense, but rather a research procedure which has a useful function in any critical discussion of welding.

It is my purpose to mention this aspect of the work in a very cursory manner in this article merely

RADIOGRAPHS BY V. E. PULLIN, C.B.E.

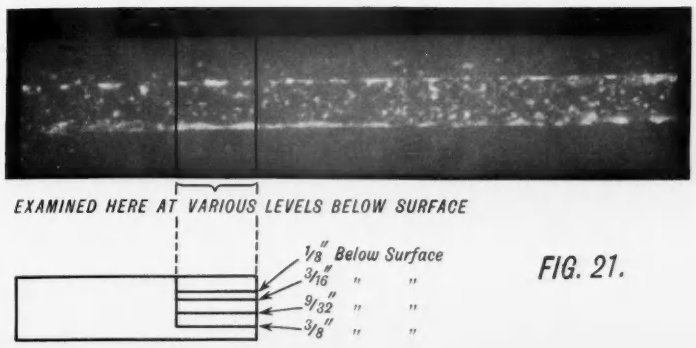


FIG. 21.

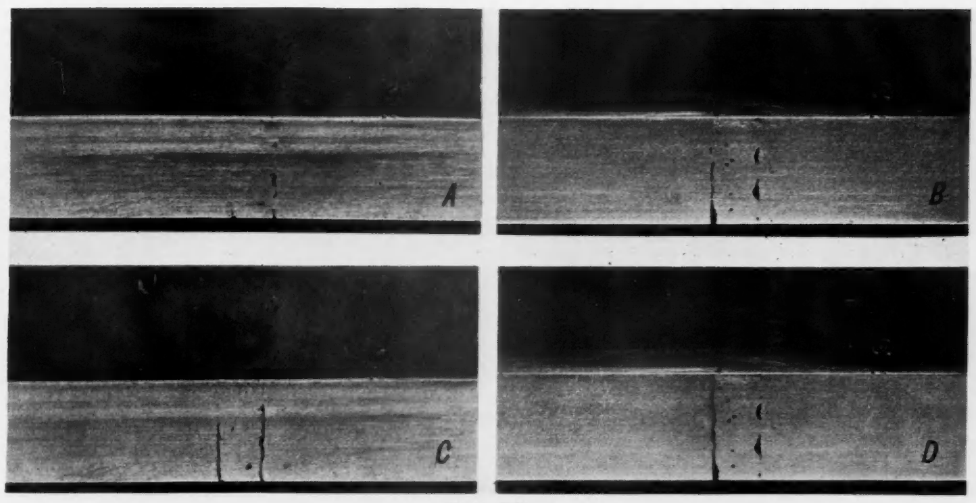
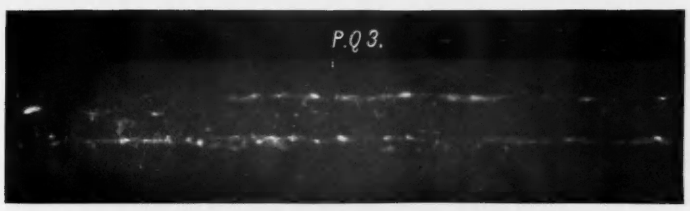
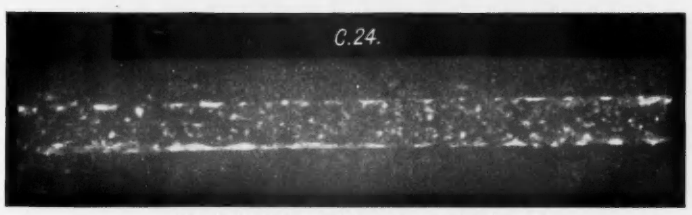


FIG. 22.



BREAKING STRESS (AVERAGE) 27·1 TONS/SQ. IN.



BREAKING STRESS (AVERAGE) 18·4 TONS/SQ. IN.

TO TENSILE TESTS, P.Q.3. IS VERY GOOD, C. 24. IS POOR. AT FIRST SIGHT RADIOGRAPHS ARE SIMILIAR. BUT NOTE HOW THE FLAWS IN C. 24. SPREAD FROM A PRONOUNCED STRAIGHT EDGE.(INDICATING LACK OF PENETRATION OF ADDED METAL INTO PARENT METAL), WHILE IN P.Q.3. THE FLAWS ARE SPREAD IN AN IRREGULAR MANNER ALONG THE WELDS WHICH DOES NOT NECESSARILY INDICATE LACK OF PENETRATION.

FIG. 23.

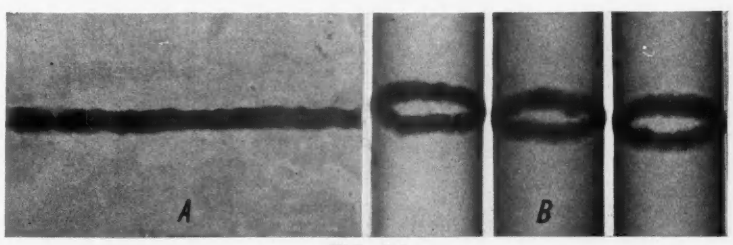


FIG. 24.

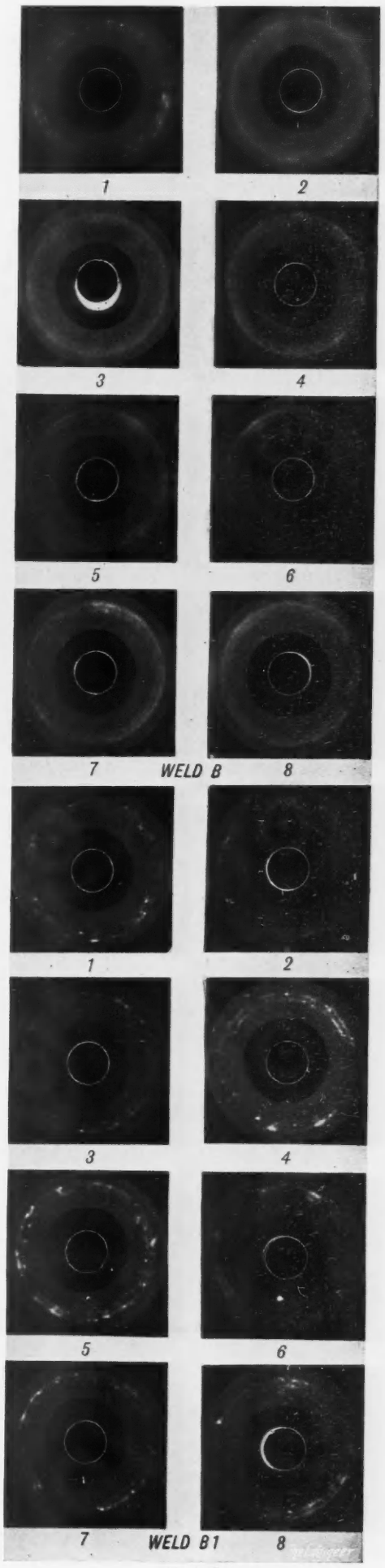


FIG. 25.

RADIOLOGY IN THE WELDING ART—RA

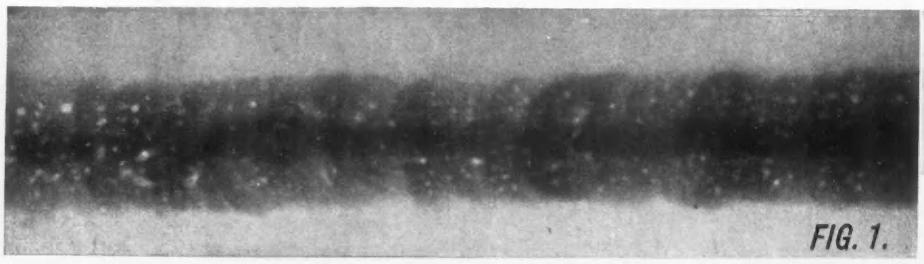


FIG. 1.

FIG. 2.

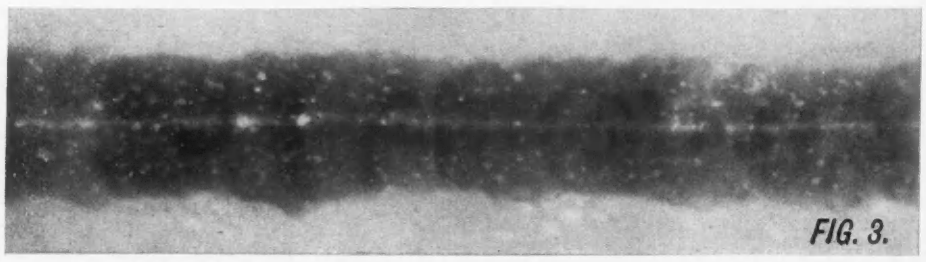


FIG. 3.

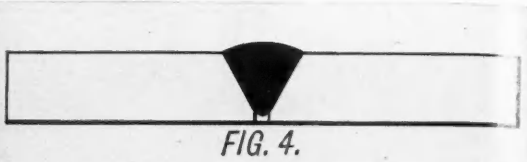


FIG. 4.

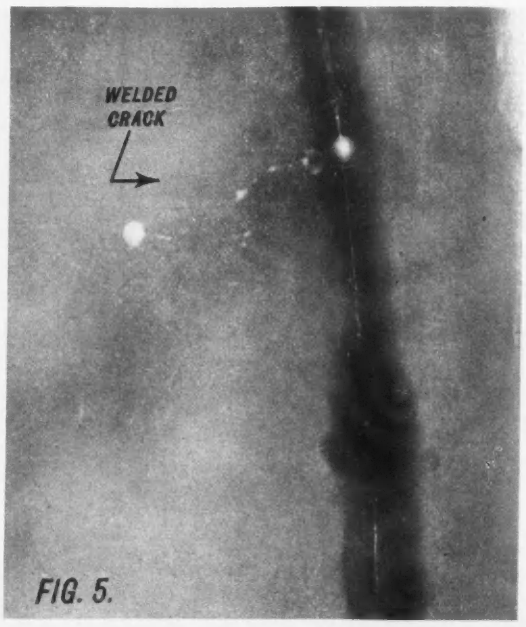


FIG. 5.

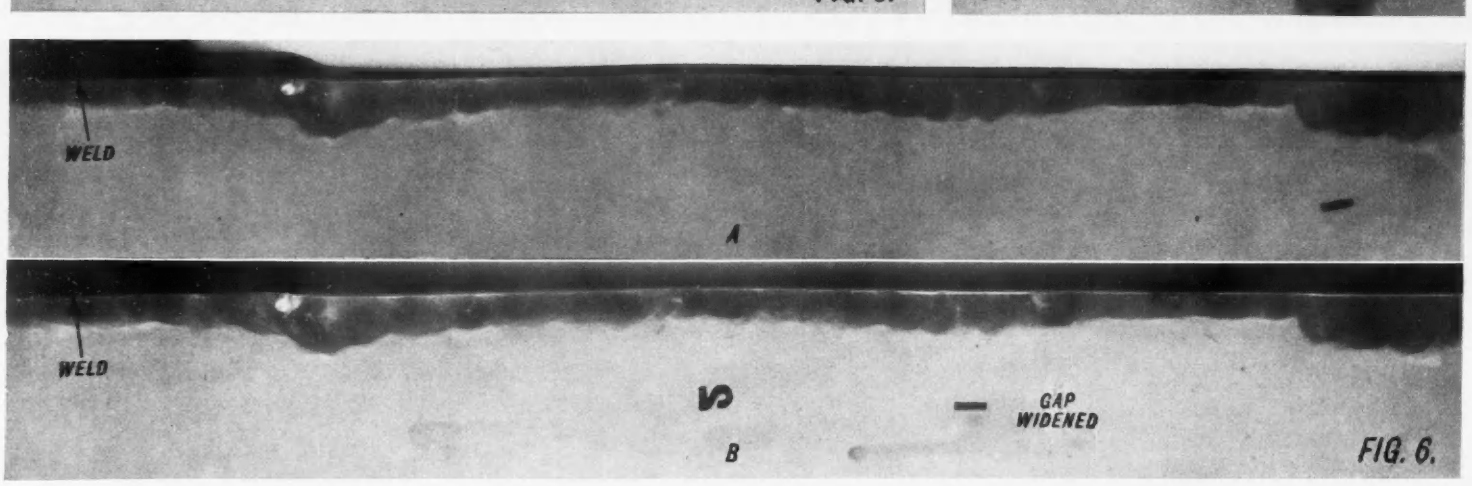


FIG. 6.

FIG. 7.

FIG. 8.

FIG. 9.

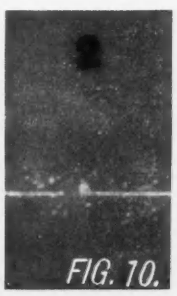


FIG. 10.

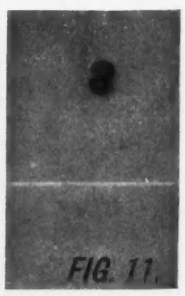


FIG. 11.

FIG. 12.

FIG. 13.

FIG. 14.

—RADIOGRAPHS BY V. E. PULLIN, C.B.E.

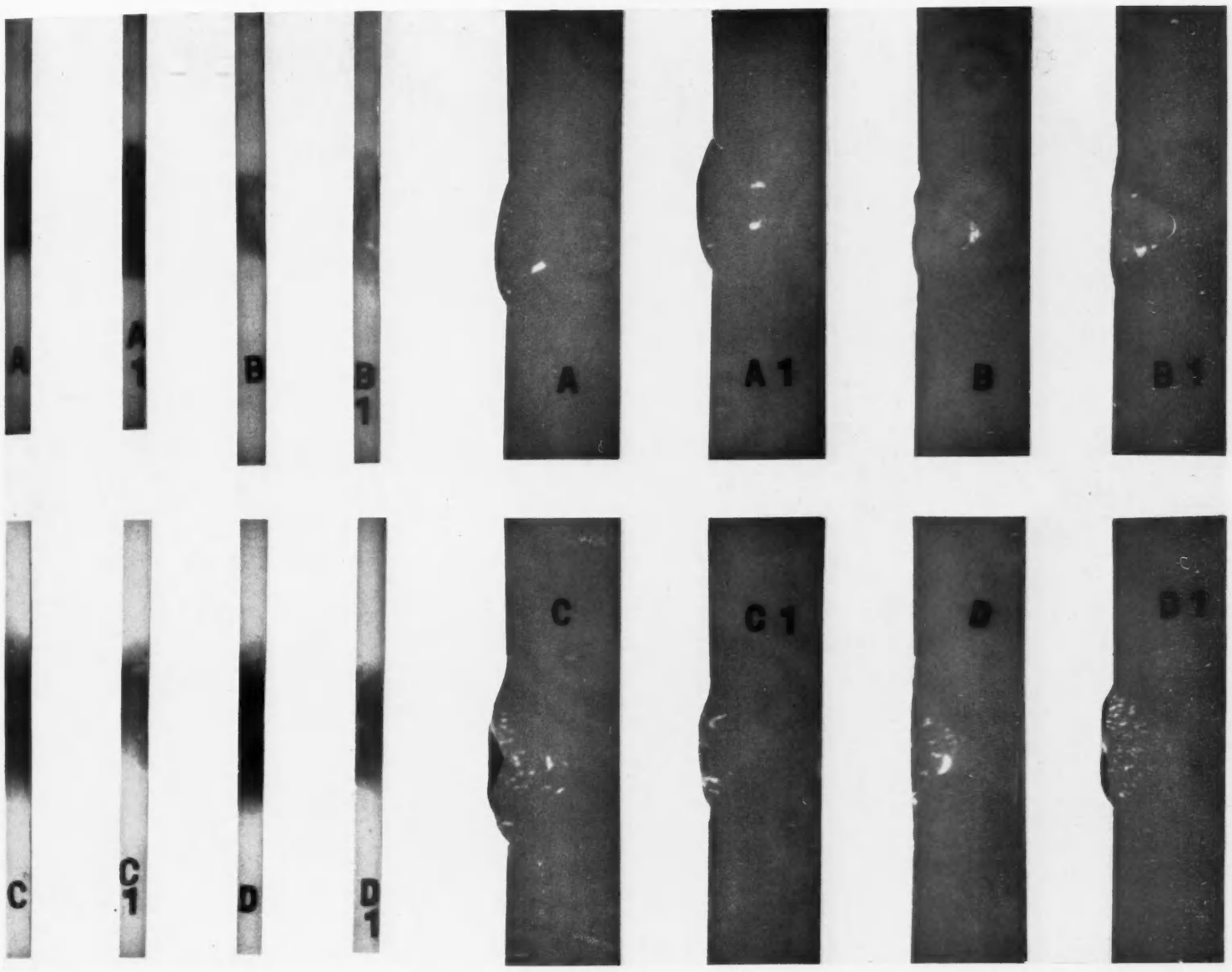


FIG. 15.

A

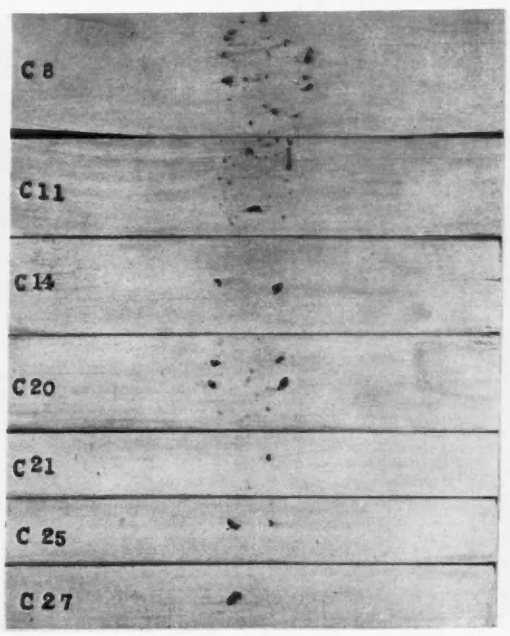
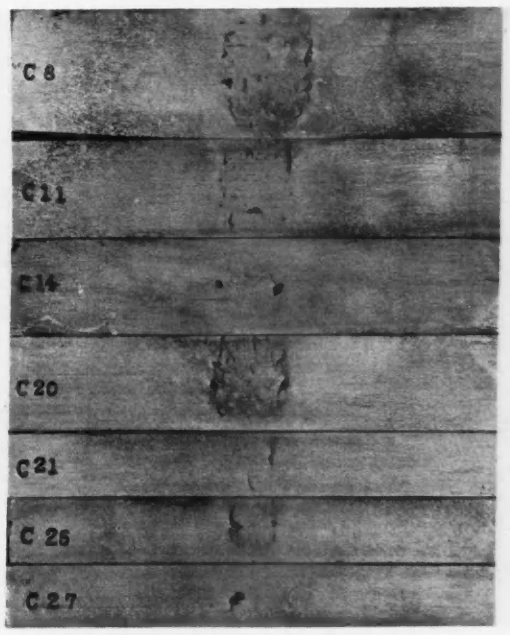


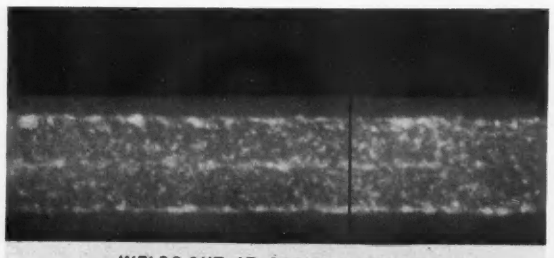
FIG. 16.



B

RADIOLOGY IN THE WELDING ART—

WELD C8 1" PLATE
ELECTRODE X

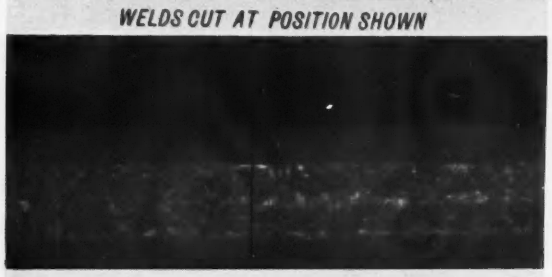


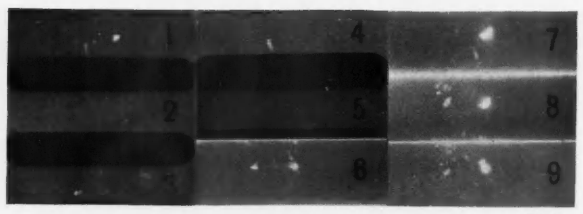
WELDS CUT AT POSITION SHOWN

6 7 8 9 1 2 3 4 5

RADIOGRAPH OF WELD

WELD C11 ¾" PLATE
ELECTRODE X

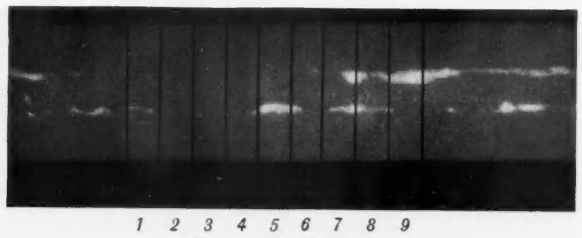




RADIOGRAPHS OF SPECIMENS BEFORE BREAKING FIG. 18.

NO.	BREAK'G STRESS TONS SQ. IN.	% AGE STRENGTH	NO.	BREAK'G STRESS TONS SQ. IN.	% AGE STRENGTH	NO.	BREAK'G STRESS TONS SQ. IN.	% AGE STRENGTH
1	23·0	77·6	4	23·9	80·6	7	23·1	78·0
2	26·9	90·8	5	25·5	86·1	8	21·5	72·6
3	24·4	82·4	6	24·2	82·0	9	22·1	74·6

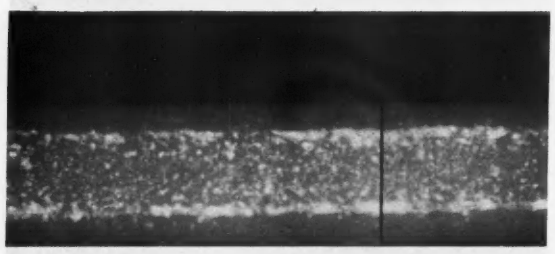
WELD C14 ¾" PLATE
ELECTRODE Y

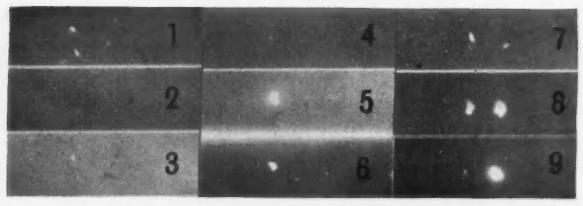


1 2 3 4 5 6 7 8 9

RADIOGRAPH OF WELD

WELD C20 ¾" PLATE
ELECTRODE X

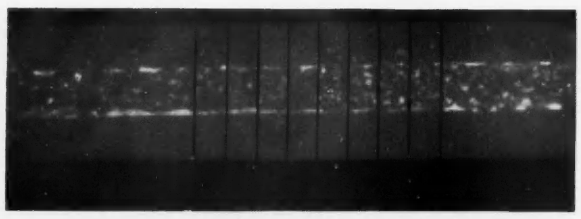




RADIOGRAPHS OF SPECIMENS BEFORE BREAKING FIG. 19.

NO.	BREAK'G STRESS TONS SQ. IN.	% AGE STRENGTH	NO.	BREAK'G STRESS TONS SQ. IN.	% AGE STRENGTH	NO.	BREAK'G STRESS TONS SQ. IN.	% AGE STRENGTH
1	28·0	94·6	4	28·6	96·7	7	25·2	85·2
2	28·0	94·6	5	26·2	88·5	8	26·1	88·2
3	29·1	98·4	6	26·9	91·0	9	25·1	85·0

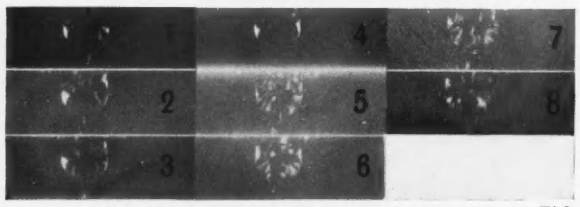
WELD C21 ½" PLATE
ELECTRODE Y



1 2 3 4 5 6 7 8

RADIOGRAPH OF WELD

WELD C25 ½" PLATE
ELECTRODE X



RADIOGRAPHS OF SPECIMENS BEFORE BREAKING FIG. 20.

NO.	BREAK'G STRESS TONS SQ. IN.	% AGE STRENGTH	NO.	BREAK'G STRESS TONS SQ. IN.	% AGE STRENGTH	NO.	BREAK'G STRESS TONS SQ. IN.	% AGE STRENGTH
1	18·7	63·1	4	17·1	57·7	7	21·2	71·5
2	15·9	53·7	5	17·8	60·1	8	22·8	72·0
3	15·9	53·7	6	18·0	60·8			

WELD C27 ½" PLATE
ELECTRODE Y

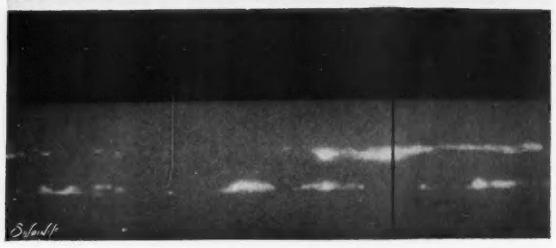


FIG. 17.

to draw attention to the various ways in which radiology may be of service to those interested in welding. On the other hand, it is not intended to give any details of this method of investigation or to explain the theory underlying it.

By the particular technique here referred to a beam of homogeneous radiation is allowed to fall on a small area of the surface of a metal, and is reflected by the atom lattice back to a suitably mounted photographic film which may be either stationary or rotating. The photographic image produced by the reflected cone of rays is a ring or rings. An examination of these spectra, as they are called, will yield information concerning the grain size. Also, it will indicate the presence of distortion of the lattice. Further, if these rings are carefully measured we may, by the application of Bragg's law, calculate the exact dimensions of the atom lattice parameter with great accuracy. It will be convenient to take two examples as an illustration of the method and to remark on the spectra.

Fig. 28 D is a diagram of the section of a weld, and the numbers on it indicate the various positions at which spectra were obtained.

Fig. 25 contains two sets of spectra numbered to correspond with the diagram. Weld B was made by several runs of weld metal. Weld B_1 was made by a single run by weaving. In both cases point No. 1 is a position remote from the weld. There are, it will be observed, two lines in each of the spectra, the reflection due to what is known as the K α doublet. The radiation is from Cobalt. The speckled appearance indicates comparatively large crystals. Thus in No. 1 of both B and B_1 the spectra present very similar appearances, as we should expect. Incidentally, they indicate comparatively large crystals. It is to be noticed that generally there is more speckliness in the spectra of B_1 than in B; therefore, on the whole, we may conclude that the crystals are larger in B_1 than in B. This suggests, of course, that in the single run weld a higher temperature was maintained for a longer time than in the case of the multi-run weld B. In position 3 (outside the weld) the crystals in both cases are smaller than, say, position 4 (inside the weld). This, again, is to be expected.

The degree of clearness of resolution of the two spectrum lines is an index as to the presence or absence of crystal distortion. It will be noticed that in the B_1 spectra there is less tendency for the two lines to merge together than in B, so that we can say that in B_1 there is less crystal distortion than in B. In other words, there has been a greater annealing effect in B_1. Further, these spectra were accurately measured and the dimensions of the lattice parameter calculated. In order to obtain a comparison with the true lattice measurement, filings were taken from the weld metal and annealed and sifted. They were then subjected to spectrum analysis and the true figure for the lattice was found to be 2·8606 Å U. In B the lattice varied from 2·8612 to 2·8618 Å U. In B_1 it varied from 2·8602 to 2·8607 Å U. Definitely therefore there appears to be less strain in B_1 than in B, which confirms our previous suggestion that the annealing effect in B_1 was greater than in B. It should be observed that actual measurement of the lattice parameter is a certain method of detecting elastic strain.

Radiology has now achieved an important part in welding activity, whether it is in practical inspection work, or as a part of an investigation programme in the laboratory. It must be emphasised that, like all non-destructive testing, its chief claim to importance is that the structure after examination is unharmed. At the same time, radiographic results, if obtained by properly trained operators, are absolutely reliable, and lend themselves to extremely accurate interpretation.

Automatic Synchronising Equipment.

No. II.

(Concluded from page 379, April 12th.)

AN automatic synchroniser was exhibited by Ferranti, Ltd., of Hollinwood, at the last Physical Society's Exhibition. It does not incorporate all the automatic features to be found in certain other equipments, and it has not yet reached its final stage of commercial development. It makes use of a thermionic tube, indicated at A in Fig. 13. When current begins to flow *vid* this tube, through the operating coil B of a relay C, the armature of the latter is pulled towards the poles and contact D is joined to E, thereby completing a circuit through the contactor operating coil, and causing the incoming generator to be paralleled on to the bus-bars. The current passing through the coil B is derived from the

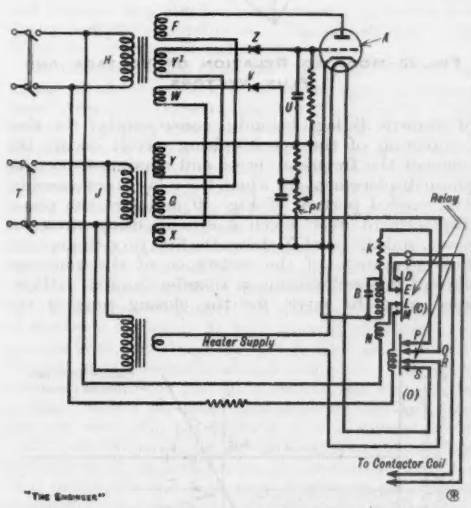


FIG. 13—FERRANTI AUTOMATIC SYNCHRONISER

secondaries F and G of the input transformers H and J, and is limited to a predetermined value by the resistance K. As the armature of the relay is pulled towards its poles, the contact L is joined to M, thus allowing a circuit to be established through the hold-on coil N and pull-off relay O, the current for this circuit being derived from the incoming generator. When the pull-off relay is energised, it disconnects the contact P from Q, thus breaking the anode circuit of the discharge tube A and also disconnects the contacts R and S, thus breaking the heater circuit of the discharge tube. Thus, after the tube has caused the contactor to operate it is cut out of circuit and its life is therefore prolonged. Generally, a heating coil is provided to warm the tube, and this may also be switched out of circuit automatically by means of another pair of contacts on the relay O.

When the generator is switched out of circuit the current through the holding-on coil N ceases to flow, since the supply is derived from the generator. Thus, the armature of relay C falls back to its original position which is the position it occupies in the absence of current from the discharge tube. Contacts L and M are therefore opened, and in the absence of current through relay O, the contacts P, Q, R, and S are closed, and provided the switch T is closed this renders the discharge tube ready for operation.

The characteristics of the discharge tube are such that anode current does not flow until the negative potential applied between the grid and cathode is below a certain value, which depends on the anode voltage. Assuming there is no difference of potential across the condenser U, the potential applied to the grid is approximately proportional to the potential applied to the anode, since each of these potentials is derived from the sum of the voltages across the secondary coils of the transformers H and J. If the potential applied to the grid be slightly increased, anode current does not flow, but if no potential is added to the grid potential a flow of anode current is established. Anode current is prevented from passing by an addition to the grid potential produced across the condenser U. The grid potential is obtained by rectifying at V the added outputs of the transformer secondaries W and X, while the anode voltage is derived from the added outputs of the secondaries F and G, the anode current being rectified by the tube itself.

The voltage across the condenser U, which stops the discharge tube operating, only approaches zero when the conditions for paralleling are fulfilled. Assuming the voltages across the secondaries Y^1 and Y are equal, the output from the rectifier Z across the condenser U will be reduced as the phase angle between the incoming generator and bus-bars diminishes and the voltage across the condenser is reduced as the condenser discharges through the resistance in parallel with it. If the phase of the voltages from the generator and bus-bars remain equal for a sufficient length of time, the condenser U is able to discharge through the resistance across it, until the voltage is insufficient to prevent the gas discharge tube from striking, but if the phase differences of the voltages begin to increase, as would be the case if the generator were running slightly too fast or too slow, the condenser begins to be recharged from the rectifier Z before it has time to discharge to the critical value.

If the voltages across the secondaries Y and Y^1 are not sufficiently equal, the voltage across the condenser U can never fall below the critical value, and the discharge tube does not strike. The secondaries F, Y^1, W, Y, G, and X may be supplied from one or more primaries in each case, and the heater coil and cathode heater are preferably supplied from the bus-bars in order that the apparatus may be warmed up prior to use. The two other condensers indicated in the diagram are by-pass condensers for smoothing in the circuits with which they are associated. A resistance is connected between the high potential side of a potentiometer P^1 and the low potential side of the condenser U to render the apparatus safe in the event of the potentiometer slider, which is adjusted to suit the discharge tube characteristics, becoming disconnected from the potentiometer. The panel on which this apparatus is mounted carries a pair of voltmeters connected to the machine and bus-bars respectively, and a synchroscope which indicates the phase difference.

A diagram of the Oerlikon Company's automatic synchronising gear is given in Fig. 14. A and B are

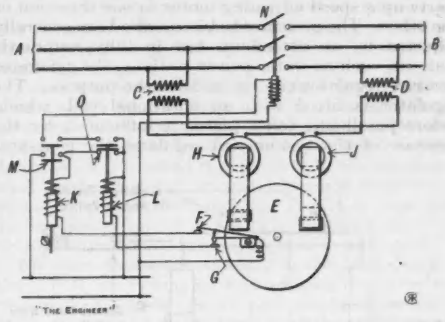


FIG. 14—OERLIKON AUTOMATIC SYNCHRONISER

the systems to be paralleled and C and D the synchronising transformers. E is a relay consisting of a Ferraris disc, which can revolve about its horizontal axis and when brought to the zero by its own weight closes contacts F and G. The contact F comes into play for a phase angle φ_1—Fig. 15—and the contact G for a phase angle φ_3. The two magnets H J act on the disc. They are connected in accordance with the method of using lamps that are dark at the point of synchronism, and they exert a torque on the disc with a clockwise direction. When the two systems are brought into synchronism the torque drops to zero and the contacts F and G are closed. The contact F controls a time relay K and contact G a relay L acting instantaneously. When the two systems approach synchronism the contact F closes when the phase angle between the systems is φ_1 and the relay K begins to work. If the difference in frequency of the two systems remains too great, the contact G is closed before the time relay can close its contact M, and as a result of the relay L coming into play the current is cut off from the relay K and paralleling is consequently prevented.

If, on the other hand, the difference in frequency becomes so small that paralleling is possible, the time relay can close its contacts before the relay L operates. When the phase angle φ_3 is reached the contact G is

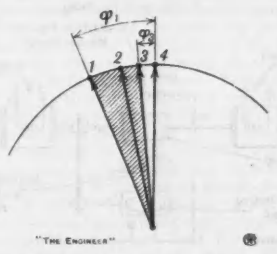


FIG. 15—PHASE DIAGRAM

brought into service, the relay L is energised, and the operating circuit of the circuit breaker N is thereby closed. To prevent the interruption of the circuit of the time relay by the relay L a second contact is provided and establishes a connection with the interrupting contact O of the relay L. The closing impulse is always given to the circuit breaker at a definite and adjustable phase angle before phase coincidence, and paralleling is prevented if phase coincidence is passed.

The factor which renders ideal paralleling most difficult to obtain is the closing time of the circuit breaker. This is remedied, however, by giving the closing impulse to the circuit breaker a short time before the correct time of closing it. The gear may be set, for example, so that the closing impulse is given 14·4 deg. before phase coincidence corresponding to the point 2 in the diagram Fig. 15. To ensure that satisfactory paralleling is secured it is essential that the circuit breakers should have very short closing times, and this condition is met to a marked extent even in the case of large circuit breakers by using operating gear with devices for storing the closing energy. It is possible to obtain in this way with 150-kV breakers, for instance, closing times of 0·25 to 0·3 second. With the aid of springs Oerlikon circuit breakers are claimed to give both reliable and rapid closing. From the point 1 to 3 in Fig. 15 the difference in frequency is measured by the time relay. When the difference in frequency drops below the permissible value the clos-

ing impulse is given to the circuit breaker at the point 3, while the coupling of the two circuits takes place at the point 4, or when there is phase coincidence. If the difference in frequency is too large, paralleling is prevented after the point 3 is passed.

In the case of fully automatic paralleling, in accordance with the Oerlikon system, a speed regulating device brings the speed of the incoming machine to the synchronous value. Two similar motors act on a differential gear, one of the motors being connected to the bus-bars and the other to the generator to be paralleled with them. The shaft of the intermediate wheel revolves at a speed corresponding to the difference in frequency of the two systems to be paralleled and acts directly on the prime mover governor and regulates the speed.

Another scheme is to make the shaft of the intermediate wheel act on a change-over switch, which starts up a speed adjusting motor in one direction or the other. The pressures to be equalised are generally adjusted by an attendant, but in fully automatic stations, such as water power stations, the generator pressure regulator can be used for the purpose. The regulator is fitted with an additional coil, which, before paralleling takes place, is influenced by the pressure of the system and regulates the generator

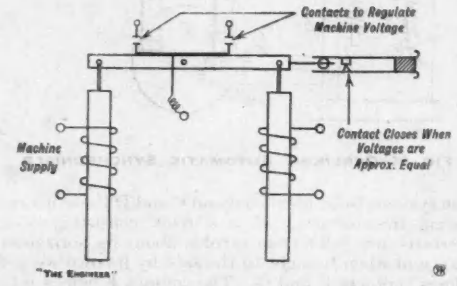


FIG. 16—VOLTAGE PARALLELING RELAY

voltage to correspond with that pressure. When the incoming generator has been paralleled the additional coil is cut out by means of a contact on the oil circuit breaker and the regulator then operates in the usual way.

Experience with automatic synchronising apparatus has led the Metropolitan-Vickers Electrical Company to suggest that the working limits in the case of the voltages should not exceed 5 per cent., the frequency error should not be more than 0·15 per cent., and the phase error not more than −3 deg. and +12 deg. from phase coincidence. The minus and plus signs differentiate between errors occurring respectively before or after the "in phase" position is reached. Apparatus devised by this company for ensuring that these requirements are met without human intervention comprises devices for voltage equalising, speed matching, and synchronising. The voltage paralleling relay—Fig. 16—consists of a pivoted

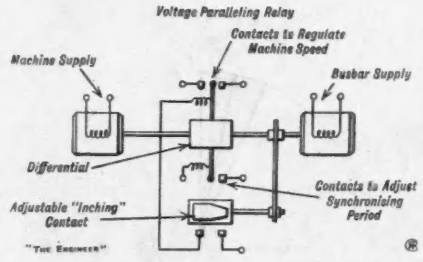


FIG. 17—SPEED MATCHER

beam with two coils, one of which is connected to the bus-bars and the other to the incoming machine. A difference in the pressures results in the deflection of the beam and the direction of its inclination is dependent on which of the voltages happens to be the highest. Contacts operated by the beam cause the voltage of the incoming machine to be regulated by control of the field exciter rheostat. When the beam takes up a mid or neutral position, however, a contact is closed in the circuit of the synchronising relay.

The correct frequency of the incoming machine is ensured by a speed matcher (Fig. 17), similar to that mentioned previously, in which a differential driven by two motors running at speeds corresponding to the frequency of the working and incoming machines makes contact according to the direction of its movement so as to adjust the supply of steam or water to the prime mover. For preventing hunting a contact device is used in conjunction with the differential for "inching" the governor control mechanism. Another contact on the differential either inserts a resistance into or shunts it across the circuits of the electro-magnets of the synchronising relay to modify its operation so as to ensure that the time taken for the oil switch to close is allowed for. This synchronising relay determines the frequency difference and phase error at which the paralleling switch is closed. It consists, as Fig. 18 shows, of three induction-type relay elements, each composed of an upper and lower electro-magnet. The coils on the upper magnets A, B, C are connected to the bus-bar supply, whilst those on lower magnets D, E, F are joined to the incoming machine, and the fluxes interact on the disc and produce a maximum torque when they differ in phase by 90 deg. An accurate indication of phase coincidence is obtained by a measurement of sine α where α is the angle of phase difference between the bus-bar and machine voltage, since the rate of change of sine α is large compared with the actual change in α when

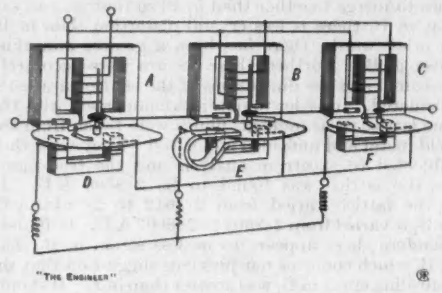


FIG. 18—SYNCHRONISING RELAY

it is in the neighbourhood of 0 deg. Two of the elements, A and C, measure the variation in sine α. The element A has a torque proportional to E b, E m, sine α, E b being the bus-bar volts, and E m the machine volts.

The voltage and flux vectors are shown in Fig. 19 a. The voltage E b is applied to the magnets A, and as the coil is highly inductive its flux lags by approximately 90 deg., and is shown by φb. For the purpose of description, E b may be considered as fixed, whilst the other vectors move relative to it. E m is shown approaching phase coincidence with the machine

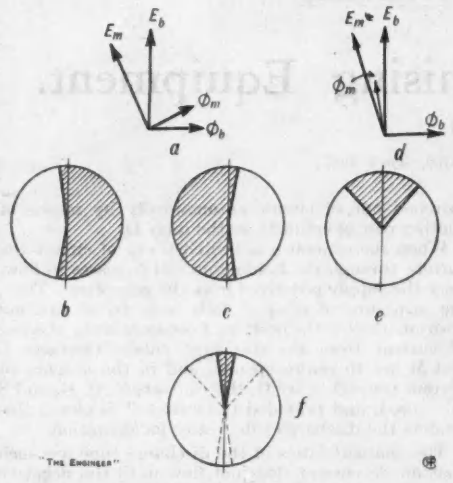


FIG. 19—VECTOR AND CONTACT CLOSURE PERIOD DIAGRAMS

frequency low, the flux φm produced in magnet D being made to lag nearly 90 deg. by a series reactance. As E m approaches E b, the torque on the disc is rapidly reduced and it becomes zero when the two vectors are in phase, and again when they are 180 deg. out of phase. With the aid of a control spring, the contact controlled by the disc is closed a few degrees ahead of synchronism, the period of contact closure being indicated by the shaded portion of Fig. 19 b. Element C is similar to element A except that its lower coil is reversed, thereby giving a contact closure period, as shown in Fig. 19, C. The frequency

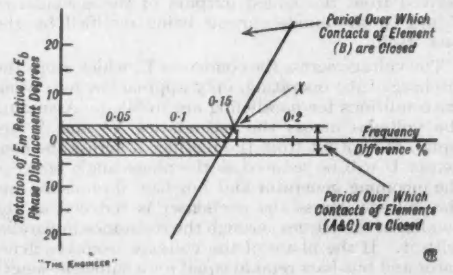


FIG. 20—RELAY CONTACT PERIOD DIAGRAM

difference is measured by element B, which is designed to measure a torque proportional to E b, E m, cos α, and the vector relationship is shown in Fig. 19, d, the flux in magnet E being brought practically into phase with E m by the use of a series resistance instead of a choke. Maximum torque is therefore obtained when the voltages are in phase, and again when they are 180 deg. out of phase. The torque in the latter case, however, is reversed, and in conjunction with the restraining spring gives a period during which the contact is closed, as shown in Fig. 19, e. A time element is introduced by increasing the disc travel to approximately 180 deg., while its speed is controlled by a permanent magnet which is adjusted so that it is not possible for contact to be made unless the frequency difference is within the allowable limit.

Owing to the inertia and breaking torque exerted by the damping magnet, the disc makes no appreciable movement from its normal position until the frequency difference has been reduced to approxi-

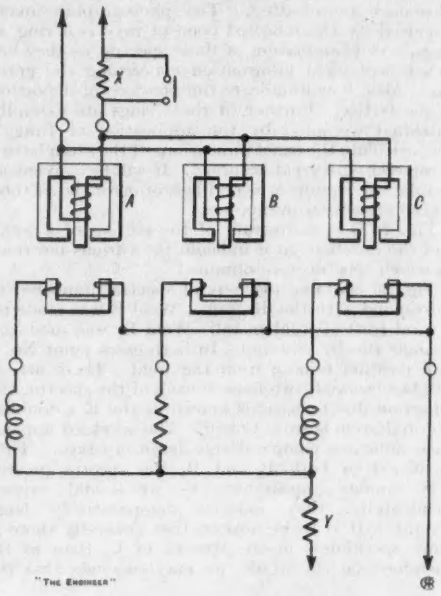


FIG. 21—MODIFIED RELAY CONNECTIONS

mately 0·25 per cent. As this difference is reduced the disc travel is proportionately increased until contact is made when the safe paralleling zone is reached. The contacts of the three elements are connected in series, and a completed circuit is therefore only established when the contact periods overlap, as shown by the shaded portion in Fig. 19 f, obtained by superimposing b and c on e. In operation, however, while the discs of A and C (Fig. 18) are closely following the phase relation, the disc

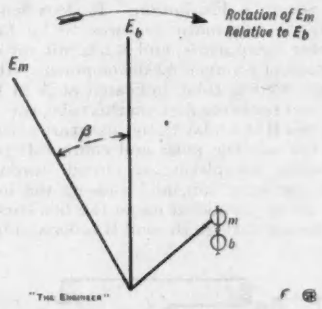


FIG. 22—MODIFIED RELATION OF VOLTAGE AND FLUX VECTORS

of element B lags behind; consequently, the first completion of the synchronising circuit occurs the moment the frequency error and maximum positive phase displacement for which the relay is set coincide. The shaded portion of Fig. 20 indicates the phase displacement over which a synchronising circuit is made, and the point X shows the first time this occurs. Full advantage of the assistance of the transient current in synchronising is thereby secured. Allowance must be made for the closing time of the

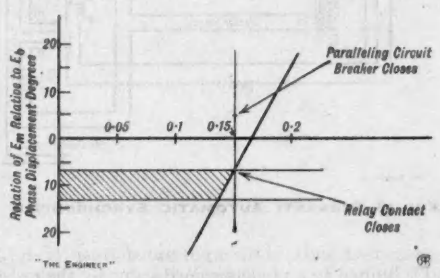


FIG. 23—RELAY CONTACT PERIOD ADVANCED

paralleling circuit breaker, which averages 0·35 sec. to 0·4 sec.

Assuming that paralleling is to take place with a frequency difference of 0·15 per cent., the average angular velocity on a 50-cycle system will be $50 \times 0{\cdot}15 \times 360/_{100} = 27$ electrical degrees per second, and for the breaker contacts to make at a phase coincidence with a closing time of 0·35 sec. the contact period of the relay would require to be advanced through $0{\cdot}35 \times 27 = 9{\cdot}45$ deg. This is accomplished by changing the phase of the flux in each of the

electro-magnets by the addition of resistances, X and Y, as shown (Fig. 21), which relates to the case of the machine frequency rising to synchronism. The modified relation of the voltage and flux vectors for element A is shown in Fig. 22, element C being similar, except for the reversal of the lower magnet coil F. The scheme advances the contact period of each of the elements by the angle β, the magnitude being determined by the closing time of the circuit breaker. The modified condition compared with Fig. 20 is shown in Fig. 23.

When decelerating (with a relative reversed rotation of E *m*) it is necessary to shunt the resistance X (Fig. 21) in the circuit of the upper coils in order to change the position of the flux vector, and thereby still maintain the condition of phase coincidence of the two fluxes with the angle between the two voltages. The operation of shunting the resistance X is carried out by the contact referred to on the speed matcher, the contact being closed only when the frequency of the machine is high compared with that of the bus-bars.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

CO-ORDINATED DEMECHANISATION.

SIR,—A year or two ago Lord Melchett—at a company meeting, if I remember aright—said that with the constantly increasing rate of introduction of new labour-saving systems and of labour-saving mechanisms, a time was foreseeable when the weekly needs of the entire world would be satisfied by the work of one-third of the world's population, or, in other words, two full days of work would suffice for all the world's needs for the rest of the week. He then examined the possibilities of the unexampled leisure and freedom which would thenceforwards be open to those (the majority) with nothing more for them to do. Already, he said, there were millions who, from youth onwards, would never have any possibility of employment.

Lord Melchett's foreview has been repeated by others in the Press many times over since then, in measure as the facts have become more generally realised. Most persons—the general public—usually comment, "Excellent! Machinery will thus deliver the world from toil and labour. That is true progress. It must be encouraged. Two days is quite enough for us to work." They cultivate the delusion that costly machines, representing great capital expenditure and interest, are installed altruistically for the benefit of the public and the consumer, and to free man and woman from "drudgery."

This "progress" is apparently bound to continue its course until perhaps the director of a company will start the daily routine work in mills and factories, on fields and on roads, by simply touching a button at his bedside at 5.30 a.m. For then, with "selective devices," it will be possible to contrive suitable "mechanical brains," and so to get rid of checkers, overseers, foremen, shop managers, and even directors.

Submarines, airplanes, and motor vehicles on road or field, may very possibly be auto-steered. Mechanisms are now already replacing competent accountants. Managers and directors may also be "economised" by certain new electro-mechanical inventions. The "overheads" will follow the workers with unlimited leisure.

The unpleasant side to all this "progress" is that, by killing off the consumers, it is causing factories to close down everywhere (Russia excepted). This is called "bad trade." Lacking sufficient markets (with millions of disemployed at home), various countries are ambitious to secure new colonies of consumers (Manchuria, Abyssinia, &c.), and the world unrest is such that nearly all countries are preparing for another war plunge, hoping for better. Yet, without any war, conquests and annexations, vast markets, equal to new colonies, are already available in almost every distracted country. Here we have about 2½ millions registered disemployed. If these people were at full-time work, they would also provide the means of existence for about 2½ to 3 millions of unemployed persons (sons and daughters, old fathers and mothers). Altogether, the disemployed and unemployed, they probably total 5 million persons in Britain, and who, on the average, require for their bare existence not less than 30s. per week (£75 per year), so that 5 millions × £75 = £375,000,000 per annum (spent weekly) would be made available to our manufacturers and producers if only for their own profit and good they formulated a means of progressive demechanisation, by dispersing with labour-saving machinery in such a way as to absorb the said 5 millions of disemployed and unemployed. This might involve a return to the rate of machines per man such as existed, say, in 1905, or thirty years ago. Manufacturers and producers would still make a good living for themselves personally, and factories would again be opened up all over the country. The chief losers would be those who live by interest on loaned money—a great new class developed largely since the late war. President Roosevelt's schemes failed because he did not carry a programme of demechanisation; and equally, I think, Mr. Lloyd George's proposed "New Deal" will utterly fail for the same reason. For 200 years the prices to the consumer have steadily increased contemporaneously with the introduction of machinery. Coal, 4s. to 5s. per ton in 1780, rose steadily, and notably since the recent introduction of underground coal-cutting machines, as recorded in THE ENGINEER. Even before the advent of Savery's universal steam engine "for driving all kinds of mills," in 1698, labour-saving machinery was found to be an evil for the majority of the population, as it still is for the great majority—hence world disemployment and "bad business."

In Danzig about 1530 the town council had ribbon looms destroyed rather than permit people to be disemployed by their continuance. In Leyden braid-making machines were introduced in 1629 and caused so much disemployment that the town council prohibited them. Various ordinances dated 1623, 1639, &c., by the States-General restricted their introduction. Another ordinance, December 15th, 1651, admitted the use of such machinery, but under specified restrictions. In 1663 ribbon-weaving machinery in Leyden caused so much loss to the hand weavers (by disemployment) that it was ultimately forbidden by the town council; and in Cologne (Koeln) its use was prohibited in 1676. Similar damage to the workers in England was caused about the same time by its introduction here. By Imperial edict, February 19th, 1685, such machinery was forbidden throughout Germany. In Hamburg such weaving machines were ordered to be destroyed by the Senate. In 1719 Charles VI renewed the Imperial edict of 1665; but in 1765 its use was allowed in Electoral Saxony. In 1722 Leopold of Leipzig made the first high-speed, high-pressure, expansive working factory steam engines.

These are but a few instances of machinery restriction by law in the interest of the most important of all people in a community—that is the consumers. To-day, rationalisation of machinery in the interest of the entire country (consumers, manufacturers, and producers) must depend upon the good sense of the industrialists, by their coming to recognise that the consumers, as a body, must be treated like a cow that is to be milked for their profit. Half-starved, the animal (the masses) cannot produce what they desire—hence "bad trade."

CHARLES R. KING.

London, N.W.3, April 7th.

THE DOUGLAS SOCIAL CREDIT SCHEME.

SIR,—Mr. Vowles' contribution to the discussion of social credit does nothing to advance our knowledge, either of the issues at stake or of the course to pursue; moreover, it appears to be based on a false appreciation of the electoral campaign now in progress.

Neither Douglas nor his supporters claim that social credit is a panacea for all our economic ills; they merely offer it as a constructive suggestion, under the conviction that a reversal of monetary policy is immediately necessary if civilisation is to survive. They do not seek to impose the Douglas plan upon the country, but rather to furnish Members of Parliament with a mandate from their constituents to initiate a necessary reform. The choice of method is left to the experts, and only results are demanded.

There seems to be an idea abroad that an engineer should not "meddle" with finance. This is a strange doctrine, considering that every engineer is professionally concerned with finance. The contrary view would appear to be more reasonable, that we suffer already from over-specialisation, and that what is needed is not a narrower field of vision but a wider horizon.

Opponents of social credit have had forty years in which to refute the alleged fallacies in the proposals of Arthur Kitson, and twenty years in the case of those of Professor Soddy and Major Douglas; but they have preferred not to come out into the open, and by refusing public debate and suppressing all reports of public meetings and literature in the daily Press, they hoped to stifle the movement in its infancy—a peculiarly un-English mode of persecution.

It is rather late in the day at this juncture to talk vaguely of grave fallacies, and dangerous tendencies, when it has already gained the enthusiastic support of actuaries, chartered accountants, businessmen—yes, and even of bankers; and has become a world-wide movement.

So in this Jubilee year let engineers for once stand together in support of Douglas, the engineer-economist and man of vision, so shall they raise themselves above the level of mere hired technicians, advance the prestige of the profession, and earn the gratitude of their fellow-men.

April 13th. NEW BRITON.

STREAMLINING.

SIR,—I much regret that my letter was worded in such a manner as to lead anyone to suppose that it was intended to underrate the detrimental effect of a side wind. The paragraph numbered 2 contained the words "it is a negligible factor," preceded by "side wind" and "flange friction." The word "it" meant the latter. Mr. Brewer unfortunately took it as applying to the former; hence his misunderstanding.

I then tried to show that the atmospheric conditions were ample in themselves to account for the resistance, without requiring increased friction.

There is no doubt in some cases an increased pressure on the lee rail, but the calculations given in my book prove that it cannot account for the great resistance which is encountered in adverse circumstances.

The fact must also be borne in mind that, in the case of a fast train, the *relative* wind (which is what matters) is never more on the broadside than about 45 deg. The Indian train which was blown over must have been going slowly.

With reference to the Canadian tests mentioned by Mr. Brewer as proving that it is useless to close the gaps between the carriages, I had some correspondence with Mr. J. J. Green, the author of the report on that subject, and have a letter from him dated "Ottawa, July 28th, 1933," which he afterwards gave me permission to publish if I wished to do so. It contains the following:—"I agree with your argument concerning the effect on train resistance of the gaps between carriages. . . . I think it would have been an improvement in the paper if this question had been enlarged upon, and the argument included. As it stands I realise it is unfair to state that gaps have no effect, merely on the basis of the single test, which was made at zero yaw."

C. F. DENDY MARSHALL.

Wonersh, Guildford, April 12th.

ORIGINAL BROAD GAUGE COACHES. GREAT WESTERN RAILWAY.

SIR,—Controversy on the rolling stock of early railways has always been keen, and the broad gauge coaches and locomotives of the G.W.R. in particular have raised much discussion.

It had been hoped that many points in dispute had been settled as the result of much research undertaken for the production of the official "History of the Great Western Railway," published by the company a few years ago. In this work it is stated that the G.W.R. original second-class coaches had four compartments and were roofed, although open at the sides (Vol. I, part 2, page 823). In the same volume (page 633) it is mentioned that "the Great Western guards were never perched on the roofs."

The many thousands interested in the development of the G.W.R. are looking forward to seeing its history in a film now being made. In the photographs of the arrival of the first train at Maidenhead, upon the opening of the line to that place, in 1838, this train is shown as having an open three-compartment carriage and a covered carriage with a guard on the roof, thus contradicting the definite statements in the official history, quoted above. It may be that Paddington now has information not available four years ago when the history was published, and is basing this episode of the film on it. To me the two vehicles in the photograph I refer to are suspiciously like those correctly used in the train at the Liverpool and Manchester Railway Centenary Celebrations at Liverpool in 1930.

This film doubtless will become of great historical value, and will be accepted in the future as an authentic picture of a G.W.R. train in 1838. For the sake of historical accuracy (if later particulars such as referred to above be not available), it is to be hoped the G.W.R. will have the scene re-shot, employing coaches the general design of which are authenticated. Swindon could easily and cheaply prepare flimsy coaches of a temporary character for the scene.

G. A. SEKON.

Burgess Hill, Sussex, April 13th.

AGRICULTURAL TERRACING MACHINES.

IN view of the attention now being given to the problem of preventing soil erosion, not only on hillsides, but on fairly level areas, one subject discussed at a meeting of the American Society of Agricultural Engineers included the methods and machinery for terracing cultivated land to reduce surface erosion. The terraces are usually 15in. to 18in. deep and 15ft. to 25ft. wide, forming a series of shallow rounded hollows and ridges. Terracing machines must move the earth a short distance and lift it 12in. to 24in. They must be reversible, follow the tractor properly on sharp curves, and take care of the side thrust. Of six types of machines: (1) The blade grader or road grader is most used, but not the most suitable; it is too heavy and costly, and requires more power than is usually available on a farm, while it needs excessive space for turning, and does not follow well on sharp curves; graders of the leaning-wheel type are best for resisting lateral pressure. (2) Elevating graders, which discharge the earth by belt conveyors, are open to the same objections, but are little used. (3) Mold-board and disc ploughs involve excessive time and labour. (4) Wood and steel drags are used, but require the use of a plough in hard soil. (5) Light terracing graders are usually too light for hard and dry ground when pulled by tractors, and offer too little resistance to side thrust. (6) Disc ploughs have advantages, and are commonly used in farming. One make has nine 26in. discs. It requires only one operator, but is not reversible and in damp soil will not work as well as a blade grader. A recent special machine is a small elevating grader with a 26in. disc delivering the excavated earth to an inclined lateral belt conveyor. When cutting 8in. deep and 9in. wide, it can travel at 3 miles an hour. Another is a tractor plough with shortened mold board and using various types of rotary cutters. It travels at 5 miles an hour, or 10 miles on the final or finishing rounds. Its small size and high speed make it a specially mobile machine which can be used also for cutting ditches and filling gullies. It consumes about 3 gallons of petrol per hour.

IN a recent address to the Cleveland Institution of Engineers, Dr. J. L. Pearson said that the new plastics industry was displacing metals in this country to the extent of about 100,000 tons a year. So rapid had been progress that the plastic industry had arrived and had attained large dimensions in an unusually short time. The new industry was challenging, with considerable success, both ferrous and non-ferrous branches of the metallurgical industry in certain fields. The most effective reply of the metallurgical industry was likely to be in the direction of bright annealing, as providing a better and more permanent finish.

The Largest Chain-Grate Stokers.

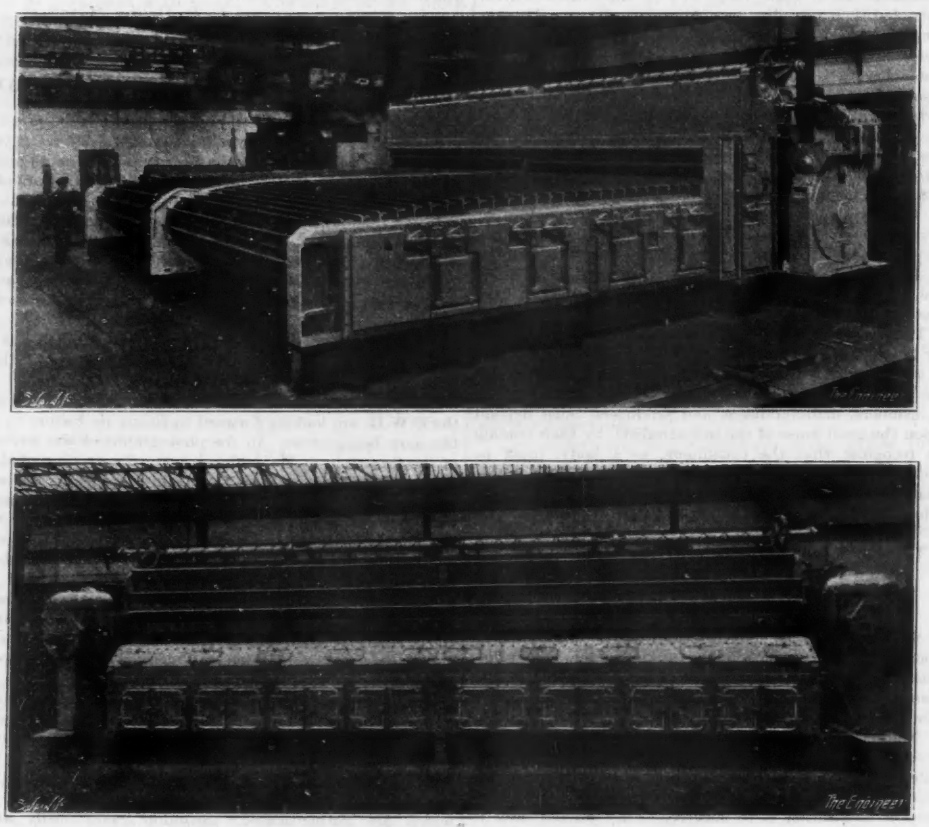
The engravings and drawing which we reproduce herewith represent what we believe to be the largest travelling chain-grate stoker ever constructed. It is one of eight being made by Babcock and Wilcox, Ltd., of Farringdon-street, London, E.C.4, for the Klip River power house of the Electricity Supply Commission of the Union of South Africa, which is operated by the Victoria Falls and Transvaal Power Company, Ltd. These stokers are 33ft. wide by 20ft. long, and compare with the largest so far installed in the United States, at the Philo power station, Ohio, which are 24ft. wide by 22ft. 9in. long. That is to say, they have approximately 20 per cent. more grate area. They are to work in conjunction with Babcock and Wilcox water-tube boilers, of which type the Victoria Falls company possess 140 examples, twenty of which are equipped with Bailey furnaces.

As will be gathered from the engravings, the stokers are of the forced draught type with closed fronts, but the fronts and ashpit can be opened and natural draught reverted to if it is so desired. The forced draught is supplied from a duct below the boiler and passes through the slack side of the chain grate, so that it picks up the waste heat in the links on its way to the fire. Beneath the working side of the grate there is a series of transverse sheet metal troughs, which are plainly shown in one of the engravings. These troughs are fitted with adjustable dampers for the admission of the draught, and enable the supply of air to the fire to be regulated according to the local conditions of combustion. Such fine dust and riddlings as do fall through the grate into the troughs drop straight through into the hoppers beneath, from which they are occasionally discharged through air-tight valves.

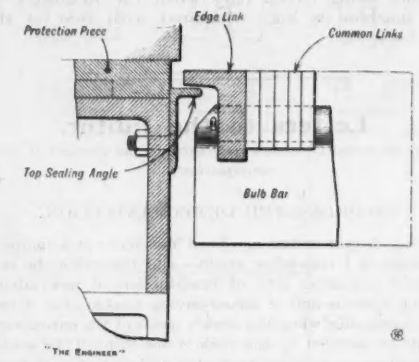
The greater part of the incombustible material, however, passes over the back end of the grate into the clinker hopper, where it is not subject to the forced draught pressure, and can be continually taken away. This desideratum is effected by the style of the grate bar links, which are very simple castings—see sketch—threaded on to transverse bulb bars. Slight bosses on the links space them apart to provide fine air passages, down which only very small stuff can fall. The back ends of the bars are carried by rest bars and bear on the front ends of the links behind them, so that a continuous grate surface is provided. The bulb and rest bars are bolted to the roller chains which carry and drive the grate, and thus relieve the grate links of all tensional strains. It is consequently a simple matter to thread new links on to the bulb bars to make good any which burn out. The slack side of the grate, on the return below, is supported on skid bars and rollers. As the links pass over the back tumbler, they fall forward clear of the rest bars and dislodge any adhering clinker. In this they are assisted by the fact that the restraining lugs on the alternate bars are of different lengths, so that the links swing relatively to one another and a scissors-like action is produced. Towards the back end of the grate there is a series of clinker bars, which rest on the grate and guide the clinkers into the hopper, the clinkers having been previously broken up by the step-by-step fall of the grate as it approaches the rear. The sides of the grate are formed by special links, as shown in another sketch, which are held on the bulb bars by split pins. These bars mesh with angle irons on the side frames in such a manner as to allow for expansion and contraction, and yet make an air seal to prevent the draught blowing by. The side frames are made sufficiently strong to carry the weight of the furnace walls, so that no secondary seal is necessary, and air leakage is reduced to a minimum. The side frames are also made quite flush, so that there are no projections to foul the travelling grate. There is ample room between the top and the return sides of the grate for a man to get inside and attend to the mechanism. The tension in the grate chains is adjusted by screw gear at the front end.

The coal hopper, fire door, and fuel valve are of cast iron, the fire door being faced on the fire side with special heat-resisting fire bricks. The fuel valve is in the form of a segment of a cylinder, which when fully open seals the front of the grate. For banked fires and lighting up the coal valve can be raised by means of gearing to present an open front of suitable depth.

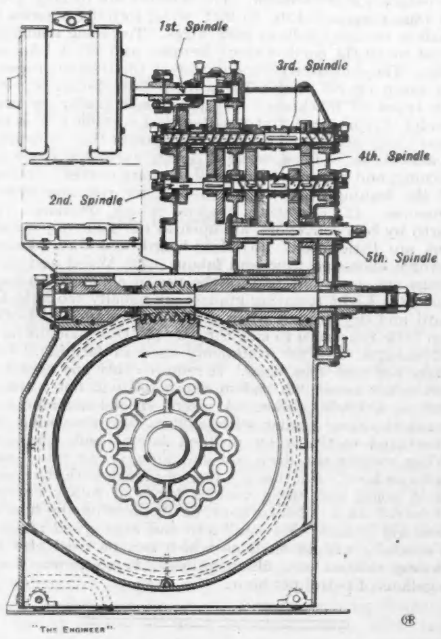
The stoker is driven by two sets of gearing, one on either side, each of which drives one half of the width of the grate. We give a sectional drawing of one of these sets of gearing. The electric motor runs at a speed of 1000 r.p.m., and through the intervention of the gear-box drives the grate at speeds ranging from about 14ft. to 68ft. per hour in eight progressive steps. The final drive is through a powerful worm gear with a ball thrust washer, and a spring controlled slipping clutch is provided to prevent damage to the gears in the event of the grate sticking. The gear can be turned over by hand if necessary.



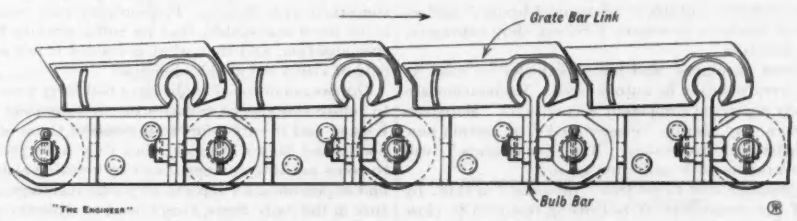
FRONT AND SIDE VIEWS OF 33FT. CHAIN GRATE STOKER



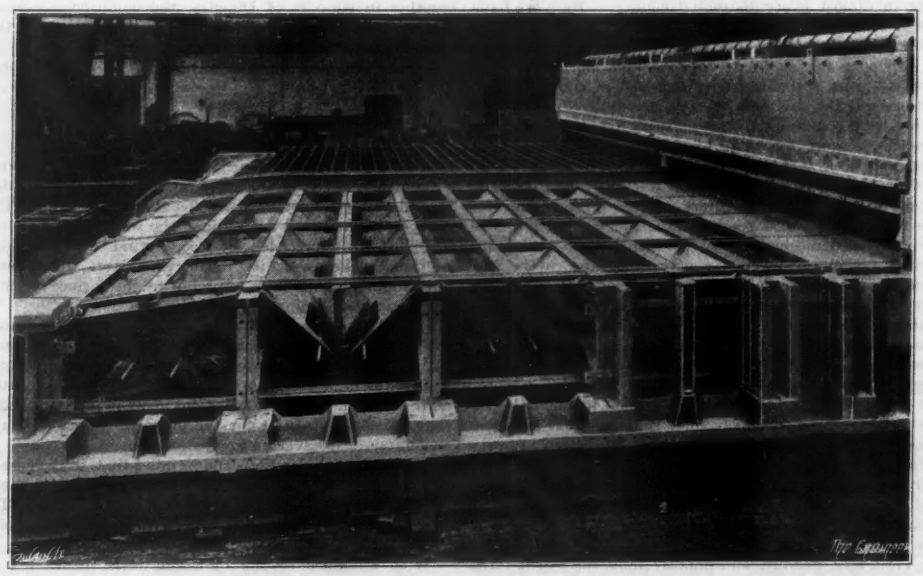
SIDE OF GRATE



GEAR DRIVE TO GRATE



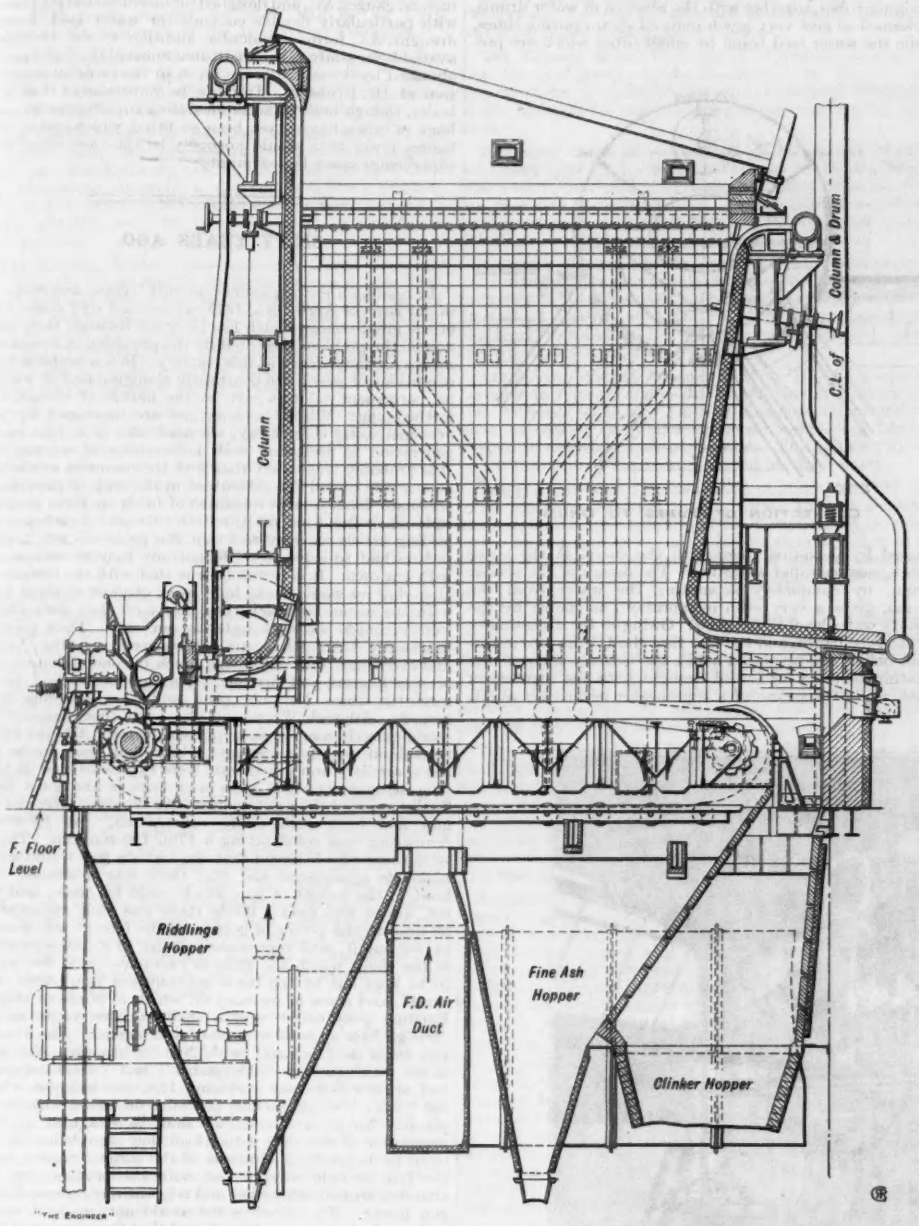
GRATE BAR LINKS AND BULB BARS



SHEET METAL TROUGHS BELOW GRATE

ARRANGEMENT OF CHAIN GRATE STOKER

BABCOCK & WILCOX LTD., LONDON, ENGINEERS



The coal which is to be burned by these stokers comes from the local colliery, and has a calorific value of 9000 B.Th.U. per lb. It has 12 per cent. of moisture, 26 per cent. of volatiles, 42·2 per cent. of fixed carbon, 19·8 per cent. of ash, and 1 per cent. of sulphur. It is intended to burn this fuel at the rate of 60 lb. per square foot of grate area, with a draught of about 1¼in. W.G. over the fire, and to generate 260,000 lb. of steam per hour (from and at) in each boiler. The power consumed by each stoker driving unit is 4 h.p.

Ilford and Barking Joint Sewerage Scheme.

ON Saturday, April 6th, the new joint pumping station and works for dealing with the sewerage of Ilford and Barking was opened by Alderman F. D. Smith, Chairman of the Joint Committee responsible for the scheme. The event marked the completion of a scheme designed to deal with the sewerage of the two towns for very many years to come.

Owing to the rapidly increasing population of both Barking and Ilford, the Councils of the respective towns have had schemes for dealing with the increased sewage under consideration for many years. As far back as 1925 the Barking Town Urban District Council was receiving reports on several possible schemes from the consulting engineers, Messrs. W. H. Radford and Son, of Nottingham. In 1926, the possibility of dealing jointly with the sewage from the two towns came under consideration, and plans were laid for the construction of new joint disposal works on the Ripple Marches. The objection to this plan, clearly realised at the time by those concerned in putting it forward, was that a new and large disposal works would be formed in or near to a district which might eventually become thickly populated. Later, when, at the suggestion of the Ministry of Health, discussions had taken place with the London County Council, arrangements were come to by which the sewage from the two towns could be taken into and treated at the northern outfall works of the L.C.C., and the Ripple Marshes scheme was abandoned. Under the arrangements agreed upon, the quantity of sewage discharged into the outfall works is restricted in any period of twenty-four hours to an amount not exceeding 50 gallons per head of the population for the time being of the two districts, and of that quantity not more than one-twelfth is to be discharged within any one hour. This limitation naturally had repercussions on the design and lay-out of the necessary pumping plant. The works comprised under the scheme eventually drawn up by Messrs. W. H. Radford and Son, of Nottingham, have now been carried out, Captain E. C. Fawcett, A.M. Inst. C.E., being the resident engineer, and have cost approximately one-quarter of a million pounds. While the present populations of Ilford and Barking are respectively 155,000 and 74,000, the new sewers and works have been designed to serve a total population of 370,000. With the opening of the new pumping station, the two existing sewage works of the two towns will disappear.

SEWERS.

To carry the sewage from the two districts to the pumping station a new trunk sewer ranging from 65in. diameter to 72in. diameter, and finally entering the new pumping station as a 74in. culvert, with a total capacity of 80 million gallons per day and a velocity of 5ft. per second, has been constructed. Certain rearrangements of existing sewers were necessary in order that their discharges might be led into the new trunk sewer.

PUMPING STATION.

The new pumping station, which is situated on part of the site of the existing Barking disposal works, is designed to receive the sewage and storm water from the two boroughs, and has pumping machinery to deal with both as quickly as they arrive, so that large storage capacity is rendered unnecessary. Photographs of the works are reproduced on page 412, and with this article. The whole of the sewage and storm water discharging from the 74in. joint trunk sewer passes through a small tapered detritus chamber, where the heavier stones and grit deposited will be extracted by a "Stott's" mechanical dredger, and disposed of on the outskirts of the site. The restriction on the quantity that can be pumped to the L.C.C. northern outfall in certain limited times has already been mentioned. All excess over this quantity will be treated as storm water and pumped into the storm-water tower. Thence it flows through a 57in. cast iron pipe into the storm-water tanks. These overflow into one another in series and, when full, any excess discharges into the river Roding at all states of the tide. The pumps installed for lifting the sewage to the L.C.C. northern outfall (a net lift of about 30ft.) are two heavy reciprocating pumps, each 175,000 g.p.h., and weighing about 90 tons; one vertical-spindle centrifugal pump, 350,000 g.p.h., and two vertical-spindle centrifugal pumps, each 600,000 g.p.h., while the pumps for lifting the storm water into the storm-water tower are two vertical-spindle centrifugal pumps, each 750,000 g.p.h. capacity. All the pumping machinery was made by Tangyes, Ltd. The normal pumping will be done by the centrifugal pumps, under automatic control, and by the hand-controlled treble-ram pumps, with their light-duty motors.

Three storm-water tanks have been constructed with a total capacity of 1,600,000 gallons, and provision has been made for a fourth. Each tank is 125ft. by 55ft., with an average depth of 12ft. After all storms, the contents of the storm-water tanks pass back by gravitation into the sewage pumps.

Close to the main pumping station there is situated a building housing the auxiliary generating plant, which, besides acting as a standby for power and light in case of emergency, will also be used in times of excessive storm. Normally, electric supplies will be taken from the mains of the Borough of Barking Electricity Department. The auxiliary installation consists of two sets of 265 kW Crompton Parkinson alternators driven at 600 r.p.m. by eight-cylinder "Paxman" vertical oil engines.

PUMPING MAINS, &c.

On leaving the pumping station, the duplicate pumping mains to the L.C.C. outfall are 30in. diameter cast iron pipes with run lead joints, carried on concrete piles and cross bearers, as in the case of all the more important pipes on the works, and are designed for a maximum working pressure equivalent to 350ft. head, in case of blockage. These pipes, when reaching the river Roding, split up into four 21in. "Stanton" cast iron mains, both flange and "Victaulic" joints being used, for passing under the river. The tunnel itself, which is about 300ft. long and 70ft. deep, was driven with the aid of compressed air, and is constructed of 7ft. 6in. diameter cast iron tubbing segments, grouted under pressure, with 11ft. 8½in. diameter shafts in cast iron on each side of the river, and having an access house on the top of the north shaft, in which is installed the pumping unit for emptying the

RECIPROCATING AND CENTRIFUGAL SEWAGE PUMPS

mains and draining the tunnel. The pumping mains are surrounded with concrete in both shafts and carried in concrete piers along the tunnel, with a gangway in the middle. These mains constitute an inverted syphon, and arrangements have been made, by means of by-passes, for sewage or river water to be circulated through the syphon by the ram pumps, at high pressure, in order to clear any possible blockage of the mains. The pumping mains from the new pumping station to the L.C.C. outfall are nearly a mile long, and after passing under the river they converge again to two 30in. pipes. Later these 30in. mains again split up into four 21in. cast iron flanged pipes, each delivering separately into the crowns of four of the five existing L.C.C. outfalls flowing to the northern disposal works, the last 60ft. of the "new sewer" being vested in the L.C.C.

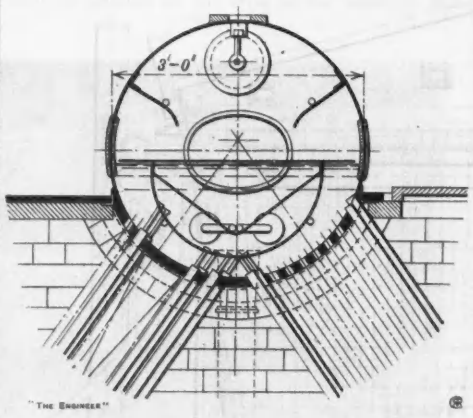
A New Water-Tube Boiler.

A VERY interesting boiler has been installed at the Northampton Polytechnic Institute, Clerkenwell. Designed by Mr. W. Yorath Lewis, the boiler appears to be a successful departure from the orthodox design, while its installation will be of great value from the educational point of view.

The boiler has been named the "U" water-tube boiler by Mr. Lewis. It has the orthodox brick and refractory fire-box, though no difficulty would arise in adopting "water walling" or any alteration in its design. Firing is by the White marine type oil fuel burner in this instance, but the boiler could readily be altered to almost any type of firing.

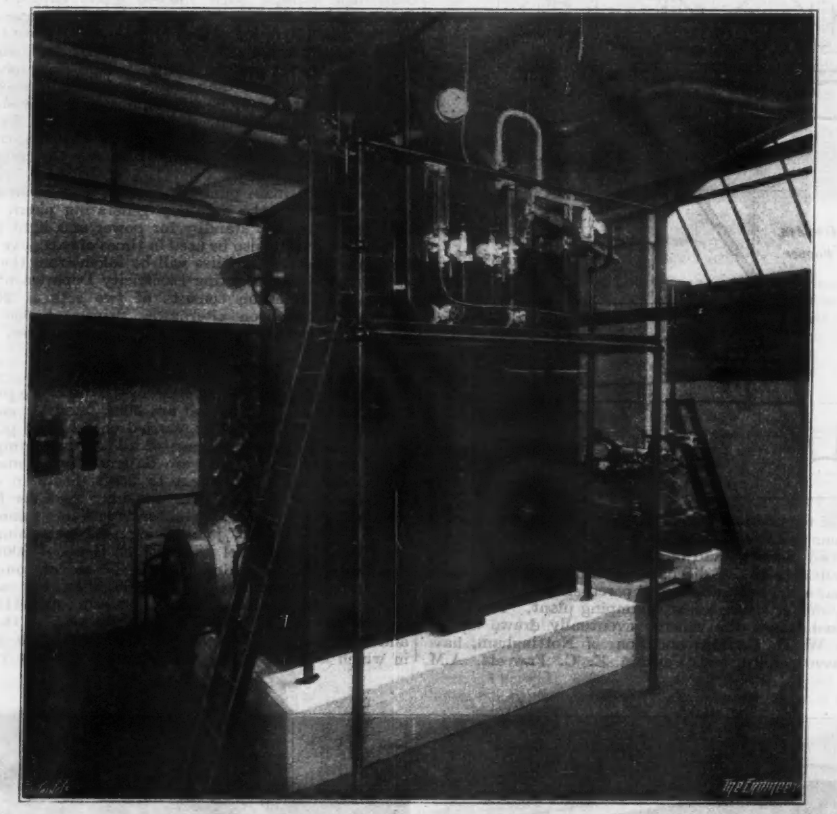
At the top of the boiler is a duplex drum of which the outer drum forms the steam chest. From this drum depend the Lewis U tubes at an angle of 45 deg. to either side of the drum. These tubes are formed of standard size boiler tubes joined at their lower ends in pairs by welding to form a U with its legs set apart about one tube diameter. The U ends rest in racks on the fire-box walls as the design abolishes the use of water drums at the bottom of the banks of tubes. The advantage claimed for this simplification is, besides the obvious saving in the cost of the drums and their installation, their weight, and the space occupied by them and their supports, &c., that the accessibility of the boiler becomes greatly improved. A boiler's weakest part is the weakest tube, and the process of getting at any tube requiring attention is normally one which is complicated out of all proportion to the work eventually to be done to it. By abolishing the lower drums, the tubes become completely accessible throughout their length, and any faulty tube can be removed without reference to any other part of the boiler, except, of course, the header drum. The header joints can all be inspected from outside, since a clear view up the tube bank can be had through the doors by the soot-blowing gear. This last gear is also greatly simplified by the absence of lower drums. It consists of a series of jets pointing up along the tubes and joined by very simple piping to a steam pipe. From these same doors the welded joints in the U tubes are immediately available for inspection or even for repair in some cases. The fact that the tubes are free at their lower ends will appeal especially to marine designers who will not have to consider racking effects, and will have only one strut supporting the header drum to allow for.

The header drum contains within itself a half drum forming a trough which acts as a water drum. From it depend small tubes which pass down inside the U tubes as far as the U itself, where their ends cross in such a manner as to feed a water stream from the pipe in one leg of the U tube into the opposite outer tube, where it is evaporated, thus ensuring uninterrupted flow of water and steam, and even heat distribution. The reduction of capacity per unit surface area of the tubes, owing to the presence of the inner tubes, together with the absence of water drums, is claimed to give very much reduced steam-raising times, while the water feed being by small tubes which are pre-



CONNECTION OF TUBES TO DRUM

heated by jacketing them with the steam in the outer tubes, ensures rapid water flow. The design of the header drum, by completely separating the water from the steam, gives a very even evaporation, as shown by the steady water level in the glass. Owing to the accessibility of the tube banks, and the fact that the U's are free at one end, baffles can be placed across the tubes to increase the heating traverse for forced draught with the greatest of ease, while the fitting of a superheater becomes a simple matter. It is claimed for the Lewis boiler that owing to the rapidity of flow in all tubes, no deposits need be feared. Moreover, in these days when clean soft water is so generally available for boiler feed, it is unnecessary to complicate design to eliminate deposit.



THE "U" WATER-TUBE BOILER

Results of Boiler Test.

Time of trial	11 hours
Oil fired	112 lb. per hour
Steam pressure	124 lb. per sq. inch
Feed water	1390 lb. per hour
lb. water / lb. fuel	= 12·4

Higher cal. value fuel, = 10,700, distributed as follows—

To water for steam	66 per cent.
To moisture in combustible	8 ,,
To drying flue gases	12·4 ,,
Radiation, &c.	13·6 ,,

Flue Gas Analysis.

	CO_2. %	O_2. %	CO. %
In combustion chamber	13·5	3	0
In tunnel bend	12·4	4·3	0

Boiler efficiency—

Higher calorific value	66 per cent.
Lower calorific value	70 ,,

By the courtesy of Principal C. S. Laws and Dr. Y. S. Docherty, of the civil and mechanical engineering department of the Polytechnic, we recently inspected this boiler at work. The boiler, which provides steam for heating and other purposes for the Institute, was being run under test conditions by a group of students. The boiler fully equipped for the carrying out of tests, with all pyrometers, gauges, &c., and designed for instructional purposes, with particularly flexible controls for water feed, firing, draught, &c., forms a valuable addition to the facilities available for study at the Institute. Some of the test figures obtained by the students are given in the table by permission of Dr. Docherty. It must be remembered that the boiler, though built to accommodate a superheater in one bank of tubes, has not yet been so fitted, which makes the figures lower than would normally be the case, since the superheater space is now empty.

SIXTY YEARS AGO.

IN reading a leading article entitled "Guns and Ships" in our issue of April 16th, 1875, we become very conscious of the great change which has occurred between then and now in the problem presented by the provision of adequate means for the defence of this country. It is a problem the conditions of which are constantly changing and of which no permanent solution can, in the nature of things, be forthcoming. While, however, we are impressed by its ever-increasing complexity, we must also note that each generation is presented with new means of solving it. It is probably true to say that with the resources available at any one period the difficulties in the way of providing adequate defence have remained of fairly uniform magnitude since the time of Alfred the Great. Reading our leading article we may feel that the problems which our fathers had to solve were delightfully easy as compared with our own. It is certainly true that with the resources of to-day we would make light work of most of them but with the resources which they possessed their difficulties were of much the same order as our own. Their prime, practically their sole, cause of concern, was the Navy and even that issue did not go much beyond the question of speed, guns and armour. The submarine had been forgotten since Fulton's time and the self-propelling torpedo, although Whitehead was even then actively at work, scarcely seemed an important factor. All eyes were turned on the developments which had been made in naval artillery and grave fears were expressed that in the long struggle between guns and armour the guns had finally asserted their dominance. At Woolwich the 81-ton gun had been successfully constructed. At Elswick, Armstrong was constructing a 17in. 100-ton gun. There were those who believed that the 180-ton gun would soon make its appearance and that there was practically no limit to the weight of gun which could be made, sent to sea, aimed and fired. While there was thus apparently no limit to the power of guns, a cubic foot of salt water, as we put it, still represented about 63 lb. avoirdupois. If the shells which the guns in existence could fire were to be kept out by the brute resistance of iron plates, we would need a sea of mercury on which to float our ships. Existing guns could send a shell at 1200 yards range through 14in. of solid iron plate well backed. The 81-ton gun could deal as easily with 20in. of armour. Yet our latest warships, the "Alexandra" and "Devastation" had armour belts not exceeding 12in. in thickness while the "Fury" would be only partially protected with 20in. plates. Naval architects, we said, were aghast at the magnitude of the force with which they were being called upon to deal. Some students of the subject argued that the best or only way to deal with the problem was to abandon armour altogether and rely entirely on speed and gun power. For ourselves we would not, we said, altogether reject armour. We believed that the solution of the problem lay in the use of double armouring consisting of say an outer 3in. skin and an inner one of 6in. metal separated possibly by a clear unbacked space of perhaps 10ft. within which the force of the explosion of any shell, detonated by contact against the outer skin, would expend itself harmlessly.

CATALOGUES.

SOAG MACHINE TOOLS, Ltd., 7, Juxton-street, S.E.11.—Stock list 217 of rebuilt machine tools.

HOLMAN BROTHERS, Ltd., Camborne.—A book on the "Newgrip" drill steel sharpener.

ADAM HILGER, Ltd., 98, King's-road, N.W.1.—Catalogue F of spectroscopic and other accessories.

JOSEPH FOSTER AND SONS, Ltd., Blackburn.—Particulars of the "Nesfield" automatic hydraulic boiler stoker.

LAMINATED GEARS, Millhouses, Sheffield.—A booklet illustrating a number of installations of laminated gear drives.

THOMAS HART, Ltd., Lambeth Works, Blackburn.—Revised edition of a textbook on rope driving, published by the firm, which specialises in the transmission of power by ropes.

SUPERHEATER COMPANY, Ltd., Bush House, Aldwych, W.C.2.—A brochure describing the design, construction, and application of McLesco superheaters, heat exchangers, and kindred apparatus.

BRITISH ALUMINIUM COMPANY, Ltd., Adelaide House, King William-street, E.C.4.—A number of books on aluminium sheet, strip, circles, alloys, rivets, tubes, heat treatment, rods, foundry data, and properties.

NORMAND ELECTRICAL COMPANY, Ltd., 3, North-side, Clapham Common, S.W.4. List No. 1134 of the "Neco Telemotor," which is a standardised arrangement of motor and gears giving a range of final speeds from ¼ r.p.m. upwards.

ELECTROFLO METERS COMPANY, Ltd., Abbey-road, Park Royal, N.W.10.—Publication B.H.E. 35, dealing with the application of instruments to boiler plant to ensure efficient combustion and economical steam raising.

GWYNNES PUMPS, Ltd., Hammersmith, W.6.—Publications 733, "Star Pumps"; 738, "English Fen Drainage Installations Equipped with Gwynnes Pumps"; 739, "Pumps for Dredging and Transporting Abrasive Solids."

JOHN M. HENDERSON AND CO., Ltd., King's Works, Aberdeen.—General catalogue No. 55-2E, illustrating a range of the firm's productions, which include ropeways, haulage and conveying plant, quarry and stone working plant, &c.

Rail and Road.

THE new President of the Institute of Transport, to take office from October 1st next, will be Sir Cyril Hurcomb, the Secretary of the Ministry of Transport.

THE Crewe correspondent of the *Manchester Guardian*, writing under date April 8th, says that the "Silver Jubilee" locomotive of the G.W.R. is to be chromium-plated throughout, and is to be run first on May 6th.

THE traffic returns for the first fourteen weeks of the year, when compared with the corresponding period of 1934, show very disappointing results. Each of the four main line companies recorded a decrease:—L.M.S., £82,000, or 0·54 per cent.; L.N.E., £213,000, or 1·87 per cent.; G.W., £50,000, or 0·80 per cent.; S.R., £165,000, or 3·47 per cent.

THE London, Midland and Scottish Railway Company has recently completed at its Derby works a new first-class club car which has been introduced into service between Blackpool, Lytham St. Annes, and Manchester, and *vice versâ*, for the use of members of the Manchester-Blackpool Travelling Club. The vehicle is equipped with seats of the armchair type and tables, and a kitchenette is fitted for the service of refreshments.

AT the annual meeting of the London and North-Eastern Railway the chairman confirmed the anticipation made herein on December 21st last that the railway companies were seeking powers to establish permanently the post-war charges for the traffic on their canals. A Ministry of Transport Order sanctioned an increase over the pre-war rates, but that expires at the end of the present year, and the Ministry has left it to the canal owners to take Parliamentary action to retain the increases.

AUTOMATIC coal-sorting screens installed by the Southern Railway at Deptford Wharf, automatically grade coal into three different classifications, varying from ¼in. to 12in. cubes. The coal screens, which were designed by the company's chief engineer, can deal with 80 tons of coal an hour. The fuel is craned out of ships' holds, dropped into a hopper, and passed on to a moving belt, which carries it to a series of sloping platforms. Here it sorts itself out through the screens, according to size, and drops into the railway wagons which are waiting beneath.

THE proposals for improving the south bank of the Thames eastwards of the County Hall have furnished Captain G. S. C. Swinton with another opportunity—in *The Times* of April 8th—to urge that the Southern Railway should be driven underground and so close Charing Cross railway bridge. We may remind our readers who wish to know how the Pennsylvania Terminal, New York, was connected with that company's existing main line to Philadelphia in the State of New Jersey, by tunnels under the Hudson, and how the station is laid out, that a description of the work appeared in THE ENGINEER of April 12th, 1907.

THE "Cheltenham Flyer," the world's fastest regular steam train, made the eight hundredth run at its high-speed schedule of 71·3 m.p.h. for the 77½ miles' journey between Swindon and Paddington on Friday, April 12th. This sixty-five-minute schedule was introduced on September 12th, 1932, when a two-minute cut from the previous time allowed made the "Flyer" the first and still the only steam train in the world's railway history to be regularly booked at 70 m.p.h. or over. Since that date the train has run over 61,000 miles, carried 80,000 passengers, and proved itself to be the best time-keeper on the company's system.

THE London, Midland and Scottish Railway has decided to increase its stock of road-rail containers by a further 220 units, comprising 50 of the insulated type for meat traffic, 20 insulated for meat or fruit, and fitted with bunkers for chemical refrigerant, 50 insulated and ventilated, fitted with water-ice bunkers for Scottish meat traffic, and 100 of a new design for conveyance of furniture. These additions will bring the total stock of L.M.S. containers up to 6635. In addition, the company is to provide 120 new wagon chassis (12 tons capacity) for conveying by express trains the insulated containers referred to above, while the immediate conversion of 150 existing wagon chassis will make them suitable for the conveyance of either the new or existing meat containers.

WORK is nearing completion on the rejuvenation by electric welding of the Sharnbrook Viaduct on the L.M.S. main line between Bedford and Wellingborough. The viaduct, which was constructed between 1878 and 1883, consists of nine girder spans, the longest being 103ft., and crosses the river Ouse at a height of more than 40ft. above the water. The repairs, which are now nearly finished, include the provision of a new steel floor electrically welded to the top of the girders, and the strengthening of the girders themselves by means of welding. The work has taken over a year to carry out, as it has had to be done without interfering with the railway traffic. Previously, the adjacent viaduct, carrying the lines used by the passenger trains, was similarly repaired by electric welding.

Two new first-class restaurant cars for service between King's Cross and Scotland have recently been completed at the Doncaster Works of the London and North-Eastern Railway Company. Each car has an overall length of 63ft. 6in., and is carried on two four-wheeled, compound bolster, 8ft. 6in. wheel base bogies. The bogies and underframes are built entirely of steel and the vehicles are fitted at each end with the standard arrangement of automatic buckeye couplers and Pullman vestibules. Each vehicle consists of a dining saloon to seat eighteen persons, a pantry, kitchen, attendants' compartment, and a toilet compartment. In these coaches each passenger is provided with an independent arm chair. The lighting scheme is mainly indirect and the body side windows are fitted with the louvre type of ventilator, which automatically extracts used air from the carriage when in motion. All cooking is carried out by means of electricity, the energy being supplied by two 7-kW generators supplemented by a battery of accumulators to enable the cooking operations to be carried on whilst the cars are stationary.

Miscellanea.

A NEW factory costing some £250,000 is to be built near Bridgewater for the manufacture of celophane products and other types of transparent papers.

THE Council of the Institute of Transport announces that Sir Cyril Hurcomb, the Secretary of the Ministry of Transport, has accepted its invitation to become President of the Institute for the year commencing on October 1st, 1935.

THE total value of the exports of oil engines of the stationary type for the first two months of the year from this country was £395,727, compared with £204,711 for the first two months of 1934. Steam engines exported during the same period fell from £86,000 to rather under £70,000.

A PARTY of forty British engineers and metallurgists has arrived at Cologne to make a tour of the ironworks and foundries of the Rhineland. They are to visit Dusseldorf, Dortmund, Essen, and Duisburg. The party consists of engineers from Cambridge, Manchester, Birmingham, and the Welsh Technical School, Cardiff.

AFTER two years' research Mr. J. B. M. Herbert, Lecturer in Physical Chemistry at Manchester University, and Professor M. Polanyi, also of Manchester University, have succeeded in producing water containing heavy oxygen in appreciable concentration. This is believed to be the first time it has been produced in this country.

THE gold medal of the Institution of Mining and Metallurgy has been awarded to Mr. Alfred Chester Beatty, M. Inst. M.M., in recognition of his distinguished services to the mining industry, and of his far-sighted vision as a mining engineer in the development of mineral deposits, with particular reference to the copper resources of Northern Rhodesia.

A COURSE on the control of malaria for engineers, planters, and those in charge of labour in tropical countries, is to be given at the Ross Institute of Tropical Hygiene, Keppel-street, London, W.C.1, from Monday, July 1st, to Friday, July 5th. The course is to be given free and includes instruction on mosquitoes and their habits, drainage and malaria control measures generally.

THREE automatically controlled lifts which, by means of loud speakers, warn passengers to stand clear of the gates and do not require attendants, have been put into service at the Strand Underground Station. With a pause of 30 seconds at the top and bottom, they make the trip up and down in 110 seconds. The time saved has enabled three instead of the usual four lifts to be used in coping with rush-hour traffic.

AN interesting and economical process for the manufacture of porous brick is being used by a refractory company in the United States, states an extract in the *Chemical Trade Journal*. Crude naphthalene is mixed with the clay, and on heating is driven off, giving the desired porosity. At the same time the naphthalene is purified and recovered. The purified naphthalene is sold at a price which pays for the crude product required in the process.

PENDING the completion of the erection of the plant for the direct hydrogenation of coal, the first shipment of petrol, some 300,000 gallons, produced by the hydrogenation of creosote at the Billingham plant of Imperial Chemical Industries, Ltd., was loaded into the s.s. "Otterhound" at Billingham on April 9th. The petrol was delivered to the Shell-Mex-B.P. Company, which, with the Anglo-American Company, is undertaking distribution on behalf of the producers, and this delivery initiates regular traffic between Billingham and East Coast ports.

THE Official Returns rendered to the Electricity Commissioners show that 1507 million units of electricity were generated by authorised undertakers in Great Britain during the month of March, 1935, as compared with the revised figure of 1391 million units in the corresponding month of 1934, representing an increase of 116 million units, or 8·3 per cent. The number of working days in the month, excluding Sundays, was twenty-six, the same as last year. During the first three months of 1935 up to the end of March, the total amount of electricity generated by authorised undertakers was 4699 million units, as compared with the revised figure of 4270 million units for the corresponding period of 1934, representing an increase of 429 million units, or 10 per cent.

A NOTE in the *Electrician* says that a new method of attaching the abrasive grains to sandpaper has been perfected by Durex Abrasives, Ltd., of Birmingham, and is said to be the greatest improvement ever made in the trade. The paper or cloth backing passes between two rollers, where a thin coating of glue is applied. It then passes between two electrodes charged with 100,000 V, the abrasive grains of which there are sometimes 250,000 to the square inch, being fed between the two electrodes simultaneously. The grains become electrified, and are forced into the glue in such a manner as to leave the sharpest points and edges standing upright, at the same time repelling each other with equal force, so as to become evenly spaced, and to provide a perfectly uniform coating to the paper or cloth backing.

AT a recent Conference between the Engineering and Allied Employers' National Federation and the Engineering Joint Trades Movement, the Director of the Federation made reference to the question of payment for the holiday on May 6th, the date of the King's Silver Jubilee, which had previously been raised by the unions. He pointed out that the Federation had no jurisdiction over federated employers, except in respect of payment for work done. It was, therefore, not able to issue any instructions in this matter. He stated that the Federation was aware that large numbers of federated employers desired to make some *ex gratia* payment to their workpeople in connection with this special occasion. The Federation was also aware that some employers, owing to financial necessity and other relevant circumstances, must be allowed freedom of action in the matter. The Federation had therefore decided to make no recommendation, but to leave the issue to the discretion of indivdual employers to be decided by them in the light of their special circumstances.

Air and Water.

A NEW Royal Air Force training school is to be established at Sywell Aerodrome, Northants. Fifteen additional hangars are to be provided, and the school will commence as soon as the extra accommodation is ready.

ORDERS have been placed by Hillman's Airways, Ltd., for six new four-engined, twelve-seater "D.H. 86" machines. These aeroplanes will be put into service during May and June, and will allow an extension of the existing Continental service.

WE are given to understand that the 46,359 tons Cunard-White Star liner "Olympic" is to be laid up in Southampton. The plans which provided for her trip to New York on June 29th preparatory to a series of cruises in American waters have been cancelled.

THE Doncaster Corporation has decided to allow its municipal aerodrome to be used as a civil flying school for the training of pupils on behalf of the Air Council. It has also given permission for occasional visits to the aerodrome by a Royal Air Force squadron.

DREDGING operations are now being carried out at the mouth of the river Loire near St. Nazaire in order to allow the French liner "Normandie" to leave on her trial trip on May 5th. The liner is scheduled to sail from Le Havre *vid* Southampton on her maiden voyage to New York on Wednesday, May 29th.

THE D.H. "Comet" aeroplane which made the record flight to Australia and back in 13½ days has created another record by flying from Croydon to Paris in 53 min. at an average speed of 220 miles an hour. This machine has been purchased by the French Government for experimental use in the South American air mail service.

ACCORDING to a recent announcement the Royal Dutch Air Line intends to fit its new air liners with oxygen apparatus for use by the crew and passengers when flying at high altitudes. On the longer routes in bad weather pilots often fly their machines at over 10,000ft. This has certainly made the journey smoother, but many passengers have complained that travelling at such a height is unpleasant.

WITH the opening to navigation of the St. Lawrence River, correspondence marked "by air mail" for Canada sent by week-end sailings of the Canadian Pacific Railway company's steamers from Glasgow or Southampton will receive onward conveyance by air from Rimouski, on the St. Lawrence, to Montreal, thereby gaining about one day to Montreal, Ottawa, and Winnipeg, and up to two days to British Columbia.

FROM the end of April the Imperial Airways liners will make the journey between London and Brindisi twice weekly in each direction. The whole flight will be made in one day, which will entail flying practically continuously for twelve hours. This service will be maintained by the "Diana" class air liners, which will leave London on Sundays and Thursdays to connect at Brindisi with the Australian mail, which is dispatched from London on Saturdays and the Africa mail, which leaves on Wednesdays.

THE 128-ton yacht "Ceto" recently launched at Portsmouth has been fitted with a wireless telephone installation which will enable the ship to maintain communication with shore wireless telephone stations, with other ships, and to receive wireless navigational and weather reports, &c., while at sea. It is interesting to record the fact that there are now nearly seventy yachts of British registry fitted with wireless for communication either by telegraphy or telephony, about one-quarter of which also carry direction finders.

THE new naval vessel H.M.S. "Enchantress" has arrived at Portsmouth, where all the furniture and plate from the old vessel of the same name is being transferred to her. She has been built to serve as Admiralty yacht when required, and her accommodation differs from that of the other sloops of her class. The "Enchantress" is the first of the class to be completed, and the Lords of the Admiralty will for the first time use her as their yacht at the Naval Review in July. The "Enchantress" is distinguished from other warships in that, instead of being painted grey throughout, her hull is black, her upper parts white, and her funnels yellow. Her armament consists of three 4·7 guns mounted forward.

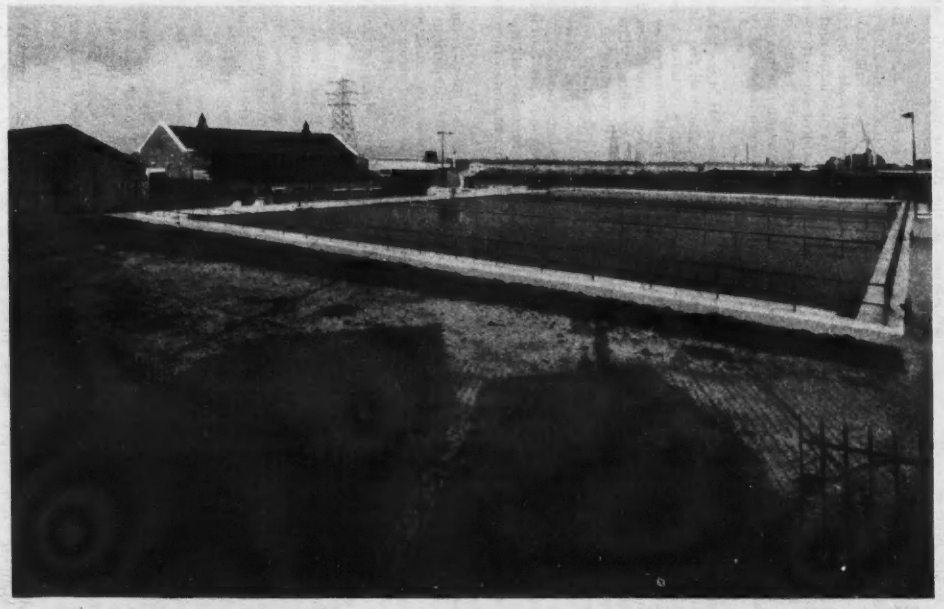
THE Under-Secretary for Air was recently asked in the House of Commons whether any committee had been entrusted with the duty of preparing a comprehensive scheme, including the ground organisation of aerodromes, for the development of internal airways, and, if so, when its report might be expected. Sir Victor Warrender, who replied, said that the Minister for Air had decided that it was essential to accelerate the survey to which the Under-Secretary referred in introducing the estimates, and the first stage would be completed within three months. The work would be entrusted to the Aeronautical Advisory Board, on which professional and technical institutions, as well as Government departments, were represented, provided that that body could undertake to complete it within the time specified.

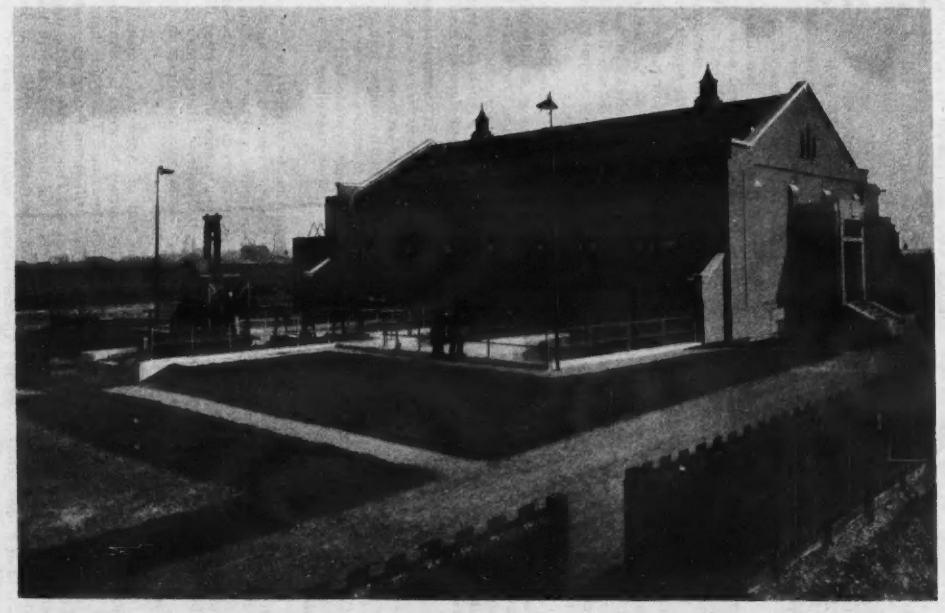
PARTICULARS have been issued of the conditions of the 10 million franc competition for the production of a successful aeroplane propelled by a heavy-oil engine, which is being organised by the French Air Ministry. The prize will be awarded to the maker of the first heavy-oil-engine-driven machine to break the existing international continuous-flight speed record of 6250 miles at an average speed of at least 112½ miles an hour. The award will be halved if the engine is not of French origin even if it is manufactured under licence in France. The French Government reserves the right to enter engines and, in the event of one of them winning, the competition will remain open for private entries, but the prize will be reduced to 8 million francs. Among the technical regulations given in *Flight* are that the flash-point of the fuel shall exceed 50 deg. Cent., that the distillation shall be 5 per cent. in volume between 215 deg. and 230 deg. Cent., and that the fuel shall have a freezing point below —8 deg. Cent. and a viscosity of 1·8 or less. The closing date is December 30th, 1936.

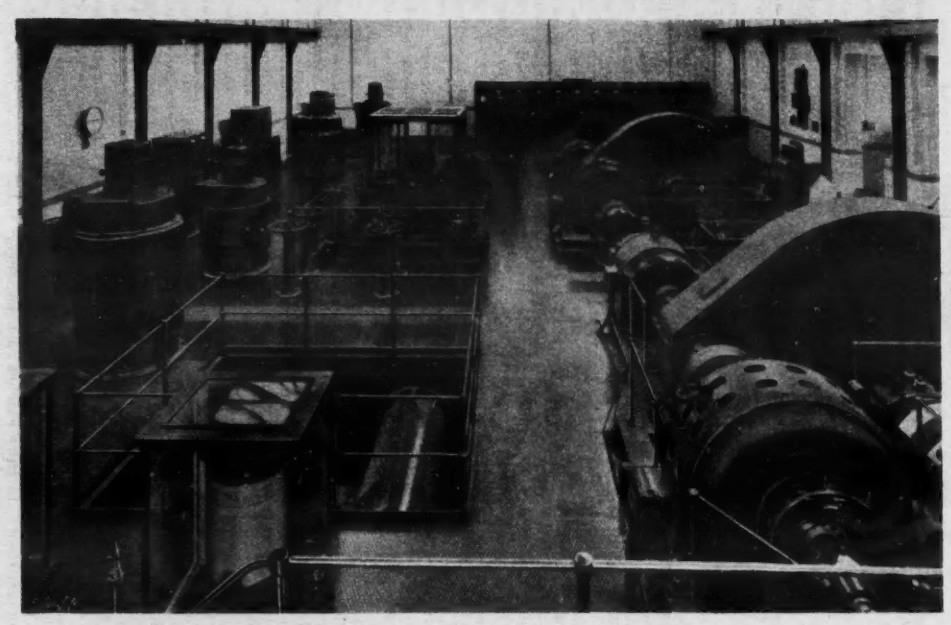
ILFORD AND BARKING JOINT SEWAGE WORKS

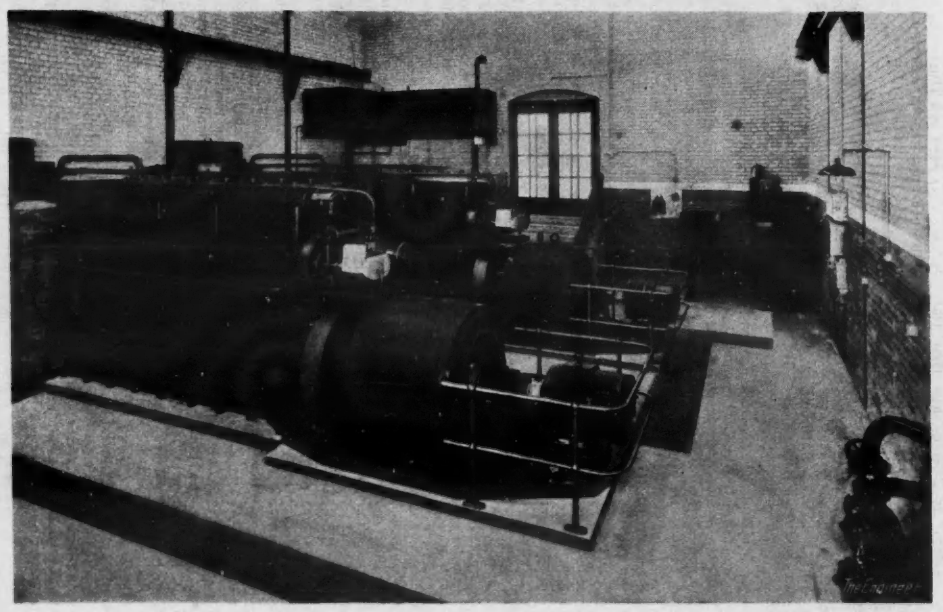
W. H. RADFORD & SON, NOTTINGHAM, CONSULTING ENGINEERS

(*For description see page 409.*)









ABOVE:—STORM WATER TANKS AND PUMPING STATION
BELOW:—INTERIOR OF PUMPING STATION

ABOVE:—PUMPING STATION, SUMPS, AND DETRITUS DREDGER
BELOW:—INTERIOR OF AUXILIARY GENERATING STATION

The Engineer

APRIL 19, 1935.

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NOTICES TO READERS.

**** If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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TRANSPORT IN UNDEVELOPED AREAS.

THOUGH the railway is now, and probably will remain for many years to come, the cheapest form of land transport, it suffers in undeveloped countries from a very grave disadvantage. Capital expenditure upon the construction of a new line, especially in the virgin country that may be encountered in tropical or sub-tropical districts overseas, is necessarily high, while the productivity of the district the line is designed to serve is frequently of a doubtful nature until a trial has been made of its possibilities. Consequently, on account of the high degree of financial risk associated with such projects, there still remain, as a glance at a few maps will show, vast regions either not served by rail at all, or only remotely within reach of it. For articles of great value, such as small quantities of precious minerals, the aeroplane, for which the capital expenditure is comparatively low, may eventually solve the problem. But where products of greater weight, or occupying a larger volume, are to be found in an undeveloped region, the high costs and small capacities of aircraft make this form of transport quite uneconomic. If the value of the goods to to be exported or imported is reasonably high, large heavy lorries or cross-country vehicles may economically maintain a connection between the district and the nearest railhead. But when goods of comparatively low intrinsic value have to be carried the cost of transport by present types of road or cross-country vehicles becomes disproportionately large, and of necessity the area concerned must rest undeveloped until such time as a branch railway is constructed to tap its resources.

Some years ago there was set up in this country the Oversea Mechanical Transport Directing Committee, with the object that a study should be made of the problem of designing some form of land transport unit, the operating costs of which in undeveloped areas might be sufficiently low to allow the products of the region to be exported at a competitive cost *via* the nearest railhead or port. This Committee, after studying the problem from many aspects, came to the conclusion that no purely cross-country vehicle could provide an economic means of heavy transport in virgin country, but that where roads, even of the very lowest grade, existed it might be possible very substantially to reduce transport costs below those existing at the time. A unit was envisaged that would carry large loads over low-grade roads on such a number of wheels that the surface would not be disintegrated. In consultation with Leyland Motors, Ltd., and R. A. Dyson and Co., Ltd., a transport unit of this type was constructed to carry 15 tons on twelve axles, and after lengthy trials in this country it was despatched to the Gold Coast for further tests under conditions akin to those which it was designed to meet. It was found that the all-in cost of transport by this means over low-grade earth roads costing between £200 and £300 per mile to construct, worked out at about 5½d. per ton-mile. This unit was bought by the Government of the Gold Coast for its own use. Subsequently, a second unit of similar type was built by the Associated Equipment Company, Ltd., and R. A. Dyson and Co., Ltd., and, after trials in this country, was sent out to Australia. A report on its performance has now been issued by the Committee, and brief reference to the report was made in a Journal note last week. The unit, after a preliminary demonstration in South Australia, journeyed 1100 miles northward to the railhead at Alice Springs in the Northern Territories, and entered upon a service in the district between Alice Springs and the terminus of the railway from Darwin at Birdum. In all, it has travelled a distance of 9387 miles over surfaces ranging from metalled roads to mere tracks, and it has encountered and overcome difficulties offered by sand hills and boulder-strewn ground, and has been called upon to negotiate sandy creeks and water-logged surfaces while carrying full loads. Although one or two minor mechanical failures have occurred, it has performed very creditably, and favourable comment is made upon it in a number of appendices to the report by various persons interested to observe how great a measure of success it would attain. Criticisms of its design have also been made. But in the main they seem to have been prompted by the fact that the unit was designed to meet conditions differing in important respects from those it has actually encountered. Considerable difficulty, for instance, was found in negotiating sand hills on rough tracks—a difficulty aggravated by the fact that the track of the unit is about 6ft., as against the 4ft. 8½in. of other vehicles, working in the same neighbourhood, so that only the wheels on one side of the unit could run on ground consolidated by the passage of other vehicles. The complaint that the ground clearance might with advantage be increased if anxiety is to be avoided obviously arises because the unit has been forced to travel over very rough and possibly boulder-strewn surfaces. As the unit was designed to operate over low-grade roads and not on tracks and over more or less trackless areas, these criticisms apply less to the vehicle itself than to the choice of the conditions it was designed to meet.

It cannot be said that as a result of these two sets of trials the members of the Committee have completely succeeded in solving the problem that was set them. By inference from comments on the tests in Australia, it may be judged that the Committee was somewhat in error in believing that a vehicle designed for use on low-grade roads would best meet the conditions, although the answer is at least possible that if a fleet of these vehicles was put into service in the Northern Territories, it would probably be found advantageous to expend capital upon the construction of low-grade roads, such as those envisaged by the Committee. But the gravest criticism of the unit is provided by the records of its transport costs. According to a calculation made by Captain E. M. Dollery, Chief Inspector, Mechanical Transport, Australian Defence Force, the official observer of the trials on behalf of the Commonwealth Government, the unit is capable of operating at a minimum cost of 2·19d. per ton-mile Australian currency. This calculation is based upon a first cost, in Australia, of £3520, a life of 100,000 miles, and an annual mileage of 18,000 miles. Could the unit actually be operated at that cost per ton-mile, there would be no reason to believe it to be other than a success, for it has operated without excessive trouble during the trials even under conditions it was never designed to face. But actually the calculation assumes that full loads are carried on both the outward and inward journeys to and from the base, while experience has shown on the Gold Coast and in Australia that not even a close approach to such conditions can be guaranteed. On the Gold Coast the average load carried was about 10 tons instead of 15 tons, and in Australia the even lower figure of 8·72 tons was recorded. In spite of the fact that the charges for return loads were fixed at 2½d. per ton-mile, as against 6½d. for the outward journey from the base, the unit frequently returned empty or only lightly laden. On the basis of an average loading of 8 tons, Captain Dollery estimates the cost at 4·12d. per ton-mile, exclusive of the costs of garage and workshop facilities, and of establishing agents in the various townships served, which would be necessary if a service was established. It may be doubted whether this figure is sufficiently low to make the proposition attractive when the capital necessary to acquire the vehicles and possibly to construct low-grade roads has also to be raised. Nevertheless, when it is remembered that it was found possible profitably to operate the vehicle on outward charges of 6½d. per ton-mile, as against ruling charges in the district of 9d. to 1s. 6d., it can hardly be doubted that the Committee is working upon the right lines, and with some hope of eventual success. It is therefore to be hoped that finance will be made available to allow the investigation of the matter to be carried a stage further in the construction of the new and modified unit that the Committee has already under consideration.

The Stability of Alternators.

FROM the earliest days of running alternators in parallel certain problems have had to be faced. Those that were met with when relatively small stations operated independently were associated with difficulties that have long been overcome and have now practically ceased to attract attention. The cyclic irregularity of reciprocating engines often led to hunting, which, on some occasions, caused the alternators to fall completely out of step. As the conditions for parallel working became better understood and sets were designed to avoid mechanical resonance, the troubles began to diminish. Suitably designed fly-wheels, damping windings on the alternator poles, and improved governing, brought great relief. But the final touch towards perfection was the advent of the steam turbine, with its even turning moment and its high-speed alternator with its solid rotor and small number of poles. Stability problems that have to be considered in these days are mainly associated with large power stations interconnected through transmission lines, which are apt to give rise to instability on the occurrence of faults, although unsatisfactory operation may be brought about by other causes, such as unstable excitation. Instability may occur during normal conditions, or, as the Americans say, "the static state," as well as during disturbances. Although up to the present the British interconnected system has shown no marked tendency to behave unsatisfactorily in this respect, stability problems have claimed a great deal of attention abroad. Experience gained in America and elsewhere has, no doubt, been utilised in designing the grid, which differs mainly from other systems in that the transmission distances are short.

The number of papers on alternator stability produced in various quarters leaves no room for complaint, although some of them have been highly mathematical and of no value to the average power engineer. By reason of the relative freedom from stability difficulties in this country, the subject has attracted relatively little attention. Only two papers devoted exclusively to the stability of interconnected systems appear to have been read before the Institution of Electrical Engineers. One was presented by Mr. F. H. Clough, of the British Thomson-Houston Company, in 1927, and the other by Mr. H. D. Horsley on the 28th of March of this year. Both are practical and devoid of the mathematical manœuvres in which some electrical writers have found it necessary to indulge. Mr. Horsley has endeavoured to present the characteristics which affect stability on a fundamental basis with a view to interpreting some of the more obscure phenomena experienced. Modern machines, it seems, are now practically devoid of exciter defects which at one time caused alternators to become unstable. The use of an auxiliary exciter for energising the field winding of the main exciter has led to the elimination in most cases of excitation instability. But when an alternator is required to excite a long overhead line on open circuit, the leading current may cause the machine to become self-exciting and so raise the voltage to an undesirable value. Several methods of avoiding this are available. One is to charge the line with two or more alternators synchronised at low voltage but at normal frequency, and gradually to increase the voltage to the normal value. Another is to connect reactances in parallel with the line while it is being excited, a scheme which, needless to

say, involves additional complication and expense. If synchronous condensers happen to be connected to the line, they may be made to reduce the leading kVA by operating them without rotor excitation. None of these schemes, however, meet the case of an alternator which, after a fault, is left charging transmission lines with practically no power load. But if there is one aspect of the subject that demands more attention than another, it appears to be that of maintaining synchronism during disturbances. The serious consequences resulting from synchronous plant dropping out of step call for no explanation. Under normal and abnormal conditions synchronous operation must be maintained. Messrs. Clough and Horsley show, as others have done, that the stability of a system depends upon the combined characteristics of generating plant, load, and interconnecting lines. Let it suffice to say, however, that the item which specially limits the amount of power that can be transmitted over a system is reactance, and that from the standpoint of stability it is advantageous to employ generators of low reactance. Such machines are unfortunately larger and more costly than higher reactance alternators, and owing to their higher short circuit ratio they impose heavier duties on circuit breakers. There is little scope for reducing the reactance of a given transmission line, although, in the case of long circuits, synchronous condensers are employed to reduce the reactive kVA and, incidentally, increase stability. As any possible change in the design of transformers can have but small effect in the direction desired, other methods of securing stability have been sought. One is to employ protective relays and circuit breakers, which will remove faults with great rapidity; but the speed of operation which American investigations are said to have shown to be essential can only be obtained by appreciable modifications to existing fault-clearing apparatus. Another scheme, described by one speaker who took part in the discussion oh Mr. Horsley's paper as a bogey, is to employ field forcing regulators, which, on the occurrence of a fault, apply a high voltage to the alternator field at the earliest possible moment. When, as under fault conditions, an alternator is suddenly called upon to deliver a large increase of reactive current, the field current is automatically increased by induction, but in the absence of rapid exciter response the increment will decrease and the flux, and consequently the terminal voltage, will drop with it. Rapid response regulators have therefore been introduced to prevent this occurring.

The scheme was apparently originally devised in America, but even in that country very rapid exciter response rates are not considered desirable under all conditions. The proper characteristics for any particular generator or synchronous condenser installation depends upon the system and the inherent stability problems it offers. It has been pointed out by American engineers that although very high response rates may be advantageous from the point of view of maintaining stability while a fault is on the system, the shock due to the clearance of the fault may be increased to such an extent that instability may result in consequence of the oscillations which follow the clearing. The highest response rates are considered to be more likely to be desirable in connection with synchronous condenser installations which are to be found mainly abroad. Other aspects of the subject might be considered, such as the merits and demerits of damper windings, the use of more sensitive governors, and the possibilities of automatic frequency control. The subject opens up many fields for discussion and provides much food for thought. Like other problems electrical engineers have had to face, that of maintaining stability has led to new ideas, as exemplified by special voltage regulators and the Isophase scheme, described, we believe, for the first time in our last issue.

Institution of Naval Architects.

No. II.

(*Continued from page 389, April 12th.*)

Presentation to Mr. Dana.

During the proceedings on Wednesday morning, Monsieur Augustin Normand made a presentation to Mr. R. W. Dana, the Secretary of the Institution, on behalf of the Association Technique Maritime et Aeronautique, as a mark of gratitude for his kindness on various occasions. Monsieur Norman said that during Mr. Dana's long connection with the Association his courtesy had been specially appreciated, both in England and abroad. It was desired also to express gratitude to Mrs. Dana for her courtesy, and the Association wished them both a long and happy life. Monsieur Normand formally presented the souvenirs, which took the form of three silver medals.

Mr. Dana said he was deeply touched by this most agreeable surprise. He had thought that he had received enough bouquets earlier that morning. A letter he had received from the President of the Association Technique Maritime et Aeronautique had warned him that he would be presented with a souvenir, but he had not expected it just then. He had lived in France for many years when he was young, and he had many delightful associations with his French friends, especially on the last occasion on which the Institution had visited France and had been welcomed at St. Nazaire, which had made one feel how very strong was the bond between ourselves and our French friends. He asked Monsieur Normand to convey to the Association his warm appreciation of its kindness.

Launching the "Queen Mary."

The first paper presented was one by Mr. J. M. McNeill, on "The Launching of the 'Queen Mary.'" An abridgement is printed on another page.

Discussion.

Professor P. A. Hillhouse, as one who, by the courtesy of John Brown and Co., Ltd., had been privileged to see the launch of the "Queen Mary," said that he could state quite honestly and enthusiastically that never in his life had he seen a more perfect or beautiful launch. One noticed the entire absence of fuss or excitement, and the whole operation had looked so easy and simple that it was difficult to imagine that so much preliminary work had had to be done to ensure success. One of the most delightful things in the paper was the energy equation, and the marvellous results to which that equation had led. The difficulty of determining exactly how far a ship would travel after launching had puzzled him for many years, but Mr. McNeill had estimated a distance of 1194ft. and the actual distance was 1196ft. Nobody would wish to get any closer than that. Professor Hillhouse then referred to a custom of measuring the pressure on the triggers by inserting between the trigger and the ship a soft copper disc contained in a steel cylinder; the disc was calibrated so that by measuring the amount by which it was compressed one could find out the actual pressure on the trigger. Taking as an example the "Empress of Japan," the component of her weight down the ways was 605 tons; the triggers gave a pressure of 214 tons, leaving 391 tons due to static friction. That was a 0·0273 coefficient, which compared with the figure of 0·0275 given in the paper—a very close agreement. But that coefficient included, not only the friction of the ways, but also the force required to overcome certain blocks which were left to be tripped when the motion of the vessel began. From records of the motion of the ship the initial friction appeared rather greater than that, and one had coefficients more like 0·04 for static initial friction.

With regard to the slope of the ways inwards, which was 1in. in 10ft. 6in., he supposed the inner edge of the ways was 1in. lower than the outer edge. He expressed a preference for sloping rather than vertical poppets. The vertical poppet required a very wide shelf, which meant a great deal of expense and a great deal of bracketing and riveting to render the shelf sufficiently strong. In most of the launches with which he was concerned it had been the practice to slope the ways and fit a very much narrower shelf, only about 1ft. wide as a maximum. That required that the poppet should be tied in at the bottom, and there were transverse plates to prevent the lower ends of the poppet spreading. That gave a very much less expensive structure at the fore end, and there was less piercing of the hull for rivets.

Discussing the equations given in the section of the paper concerning stern immersion, he presumed that they referred only to the ship and that the coefficients applied to the ship and not to the model. The first equation, to be quite general, should have a length term. He applied it to the ship, using "L" for the ship and "l" for the model, and said that the figure worked out at $2 \cdot 5\ V_s$ for the ship, as given in the paper, and for the model it worked out at $2 \cdot 5\ \frac{l}{L}\ V_s$. Similar remarks applied to the second formula.

Mr. G. S. Baker (National Physical Laboratory) said that he had noted, as had Professor Hillhouse, the want of dimensional correctness in the equation given in the part of the paper dealing with stern immersion, and he had wondered whether it were possible to calculate the point at which the after poppet was at its maximum immersion. The author had assumed static conditions, but in the launch of a ship there was no such thing as a static condition—at least one hoped that that was so—until the vessel was afloat. Therefore, if one found something going wrong, it was obvious that one's assumptions were wrong. By a process of comparatively easy graphical integration the complete movements of the ship from the time the after poppet lifted off the ways until the ship was completely afloat could be worked out. At the time when the after poppet left the ways the moment of buoyancy was equal to the moment of the weight about the fore poppets, and any other buoyancy added to the ship from that time must be such that its moment was balanced by the pitching moment of the ship. It could also be assumed that at this period the velocity of the ship down the ways was always steady. Therefore, time was related to distance by a linear ratio.

If

B is the buoyancy,
$B+b$ the buoyancy when the ship has travelled another z ft.,
I the inertia about the fore poppet of the buoyancy b,

the instantaneous pitching moment of the ship will be given by

$$b\,y_2 = I\,\frac{d^2(\theta-\alpha)}{d\,t^2}. \quad . \quad . \quad . \quad . \quad (1)$$

where α is the angular departure of the keel from the ways. It is known that the speed down the slip V_s is always practically constant at this period of the launch, and one can therefore write

$$\text{Time} \times V_s = z \text{ the travel} \quad . \quad . \quad . \quad (2)$$

By assuming a series of movements of about 10ft. and for the new immersion of fore poppet, assuming some two or three α values, one can plot for each assumed α a curve of $\frac{d\,\alpha}{d\,t}$, $d\,t$ being given by equation (2). For each α value, the values of $b\,y_2$ and I are calculated, and when equality of the two sides of equation (1) is obtained the α value for this z value is known, and so step by step the full movement is followed. The maximum immersion is obtained when the change of α for a 10ft. movement=(inclination of way) $10 \div h$, h being the length between fore and after poppets. The author's coefficient of 2·5 could only apply to the special case of this particular ship, and was not a general coefficient.

With regard to the author's comparison of the calculated and measured stresses on the promenade stringer plates, he said that the discrepancy varied between 30 and 45 per cent.; the author had suggested that the bending moment was partially absorbed in work done in flexural movement of the steel structure. An examination of Fig. 10 of the paper showed that bending of the hull was taking place some 12 seconds before the stress instruments on the stringer plating had shown any material movement, and that did not appear to represent the work being done by flexural stresses on the ship. Some of the discrepancy might arise from the settlement of the steel structure during its first movement, but one could not have a ship bending some 4in. without stress on its plating, and then bending another 4in. with a plating stress. Mr. Baker suggested that either the instruments were badly placed or were not recording correctly. He asked for more information about the placing of them, and suggested that the calculated stresses were more correct than the measured stresses.

Sir Westcott Abell said probably the launching of the "Queen Mary" would be regarded as one of the outstanding engineering feats of King George's reign, and perhaps as one of the seven wonders of the world. To free 37,000 tons weight, predict the distance it would run, and then bring it up within 1½ minutes, was certainly an achievement of which anyone might well be proud. He had no fault to find with Mr. McNeill's technical achievements, but criticised his statement that naval architecture, by its very nature, was essentially empirical. Mr. McNeill had conducted the investigation of his problems in a very scientific manner; whenever he had met a difficulty he had devised the simplest possible way of obtaining a measure, by experiment, of that difficulty. Surely that was not empirical; as the result of his investigations he had kept a huge weight under control throughout the operations, and one could not regard that as empirical. It was a very scientific achievement. Nearly all work of that kind could best be done by the use of the energy equation; we could get very near to the actual truth in every problem concerning the movement of a ship. To see that method applied so beautifully was a further justification of it.

Mr. H. G. Williams, comparing the launch of the "Queen Mary" with that of the "Nelson," which was the largest vessel he had been responsible for launching, said that while the weight of the "Queen Mary" was 84 per cent. greater than that of the "Nelson" at launch, and the absolute magnitude was very much greater, there were no particular difficulties in launching the "Queen Mary" in excess of those applying to the launch of the "Nelson," except that there was a shorter distance into which

to launch her. He shared with Professor Hillhouse admiration of the energy equation devised by Mr. McNeill, which, by reason of the very exact results that were given, was worthy of careful study by anyone concerned with a similar launch in the future.

In the paper the author had stated that "as the component down the ways of the weight of the vessel is resisted by the ways' friction, water resistance, and drags, it is interesting to assess the relative amount of these forces." Surely, said Mr. Williams, the relative amount of those forces varied from instant to instant. Did it not mean that the figures given by the author with regard to those forces referred to the total energy absorbed by the different forces? It would appear from Fig. 8 of the paper, which gave curves of forces and resistances, that one could not establish a constant ratio for the whole operation between the ways' friction, the water resistance, and the drag friction.

The normal practice of launching on two ways was adopted by John Brown and Co., Ltd., after careful investigation of the use of four ways (which latter practice was adopted in launching the "Nelson"), and the decision was quite intelligible. He imagined that a case for the use of four ways was not likely to be made out in any instance except for a ship with heavy weights of side armour or very heavy weight in the wings, and possibly to suit some particular conformation of the launching berth. Records taken during the launch of the "Queen Mary" appeared to be very complete, including velocities, angular movements and stresses in the structure of the ship, and these records would prove very valuable.

Mr. E. F. Spanner agreed that the structure of a ship could hardly be expected to respond instantaneously to the stresses on her. When the "Calliope" was launched at Pembroke Dock twenty-one years ago he had taken records of the stresses and the strains in the upper deck, and he had mentioned at that time before the Institution that it was very necessary to take very careful note of the time lag of strain behind stress. If there were a definite lag of strain behind stress in the case of a complicated structure, such as that of a ship, it could only be found out generally at a launch, because that was the only occasion on which one could get a definite relation between the stress in the ship and the calculated strain; when a ship was at sea one could not measure it.

He did not agree with Mr. Baker that the calculated figures were to be relied upon altogether, except the ship be given time to take up the strains which the calculated figures indicated she should carry, and he felt that, at any rate in the case of all His Majesty's ships, stress-strain records should be taken at all launchings in order to secure a proper relation between the stresses and strains. It might be, as Mr. McNeill had suggested, that the giving of the ship had some effect in producing the time lag. If so, it was obvious that when we built all-welded ships, as we should do eventually, or built some with part of the structure riveted and part welded, we might run into trouble, for there would be no possibility of slip in the welded joints, whereas there was in the riveted joints. The matter was of very great importance when inquiry was held into the cause of straining damage sustained under heavy weather conditions. It would appear from the figures which had been obtained that the breakages which occurred at sea could not be related directly to the stresses assessed from the wave curve without making allowance for the lag effect. He did not agree with Professor Haigh with regard to certain relations which were assumed as a whole concerning stresses and strains in ordinary specimens of materials; but there seemed no doubt that the evidence Mr. McNeill had given of the lag of strain behind stress in a complicated ship structure was a matter of which we should take definite note.

Mr. McNeill, replying to the discussion, said he appreciated Professor Hillhouse's valuation of the energy equation given. It had taken a considerable time to solve, and the difficult part about it, of course, was that of the water resistance. Having studied other launches, he and his colleagues were quite definite that the coefficient given for water resistance could be related to each particular case, and that had enabled them to build up the equation with confidence. The coincidence in regard to travel was a little too accidental, but the comparative agreement throughout the length of the curve was good enough proof that the energy equation could be right. Several attempts had been made to show that in previous papers, and the reference in the present paper was an extension of what had been attempted before. The equation might not yet be in its final form.

No attempt was made at the launch to assess the pressure on the triggers. Those concerned were satisfied that the triggers were quite able to take the stress, and they had been content with that.

With regard to the inclination of ways inwards, it was correct to assume that the inside was lower than the outside by 1in., as Professor Hillhouse had done. In many cases, it was made three times that amount.

Sloping poppets were advantageous for vessels of smaller size, but in the case of the "Queen Mary" there might have been risk of the top of the poppets coming below the water line after the vessel was in the water. The poppets were easily removed within about three days of the actual launch.

The equation with regard to run, stern lift, and stern immersion was applicable, of course, to the "Queen Mary." It was not given as for other ships. In reply to Mr. Baker, he said that he had an equation which would give practically coincident results, but it assumed such cumbrous form, and one required so much time to work it out, that the simpler equation he had given in the paper was much to be preferred.

He was unable to follow Mr. Baker's references to the inequality of the stresses. The placing of the instruments was mentioned in the paper. They were placed about 27ft. forward of No. 5 boiler hatch, the two meters on the deck being placed on the stringers.

The remarks of Mr. Spanner, which confirmed that there was a time lag between the stress and the strain, more or less answered the questions put by Mr. Baker.

Mr. Williams was correct in suggesting that the resistance he had referred to should be really energy. It was thought that "resistance" was a term well enough understood. The percentages naturally referred to the areas between the curves, as shown in Fig. 8 of the paper.

Dealing with the use of four ways or two ways, Mr. McNeill said that the conditions applying to the "Nelson" were entirely different from those applying to the "Queen Mary" in that the "Nelson" was of shallow depth relative to length, had a good deal of side armour, and probably very much weaker floors. There was much to be said for the use of four ways in such cases. But he was not convinced that any launch could not be performed just as well, if not better, with two ways.

The other paper read on Wednesday morning was one entitled "Transport of Refrigerated Cargoes under Modern Marine Practice," by A. R. T. Woods

In introducing his paper, Mr. Woods made reference to the last paper on the same subject, which was read before the Institution in 1903 by Mr. Robert Balfour. In that paper, he said, figures were given for the imports of carcases for the period of years between 1880 and 1902. In 1880 the only trade in refrigerated meat was that of 400 carcases which were imported from Australia. In 1902, however, the trade in refrigerated produce had increased to 724,297 carcases from Australia, 3,668,061 from New Zealand, and 2,827,496 from the River Plate, totalling 7,219,854 carcases, representing a weight of about 230,207 tons.

These figures, Mr. Woods pointed out, were in striking contrast with the imports for the twelve months up to the end of 1934, which included a wide range of meats, dairy produce, and fruits of all kinds.

Refrigerated Produce Imports for Twelve Months of the Year 1934.

	Tons weight.	Value in £.	Cubic feet of space required.	No. of voyages at 5000 tons.
Meats—				
British Dominions	823,399	44,106,256	69,412,066	164·67
South America and other foreign countries	676,566	30,633,721	62,152,973	135·31
Meats—Total	1,499,965	£74,739,977	131,565,039	299·98
Fruits—				
British Dominions	547,731	9,318,975	36,469,679	109·54
South America and other foreign countries	356,873	7,239,194	36,149,200	71·37
Fruits—Total	1,004,604	£16,558,169	72,619,879	180·91
Grand total—Meats and fruits	2,504,569	£91,298,146	204,184,918	481

What an interesting field of speculation was opened up, Mr. Woods said, if one attempted to visualise the position of the British shipping industry if it were not for the vast volume of specialised tonnage engaged in the refrigeration trades, and yet three-quarters of a century ago little or nothing of that sort of overseas transport existed. To-day this country was the principal market for the greatest proportion of this produce. We were daily urged to "eat more fruit," "eat more meat," "eat more butter, eggs, &c." The nation's capacity for absorbing foodstuffs, he pointed out, must have its limitations, but still the supply came along in ever-increasing quantities, and whatever tonnage is called for, it could always be supplied. The time was certainly drawing near, however, when a watchful eye must be kept to see that producers did not over-supply the market.

It had been said that the ships now being built were too large, and in this statement one could see good reasoning. Vessels of about 300,000 to 350,000 cubic feet, or even smaller but faster, were what might be termed a handy size, although not long ago such sizes were looked upon as being too small. Yet to-day markets have changed, and consequently new conditions have to be faced.

Another view of the situation was—assuming that the total quantities shipped remained stable—that if the tonnage units were reasonably reduced, the total number of ships would have to be increased, and, incidentally, more crews would have to be employed.

It was the opinion of many that the time had come when the building of very large and fast ships was getting beyond the reasonable limitations of practical commerce, as such development had the appearance of "putting all the eggs in one basket."

In his paper, Mr. Woods said, he had only been able to discuss the various problems of the carriage of perishable produce in the most elementary way, with the main object of arousing the interest of those who in the past might not have given the subject their serious consideration.

Before going on to more general aspects of the subject, the author paid a warm tribute to the life work of the late Sir Willaim Hardy, who, he said, had made the science of refrigeration and its practice peculiarly his own, and had added very much to it.

Mr. Woods then dealt with such subjects as hygiene, humidity, air circulation, and the preparation and sterilisation of chambers for the carriage of meat, fish, fruits, and eggs. After touching upon such matters as bacterial and mould formations, and the precautions to be taken against them, he spoke of the uses of carbon dioxide and of ozone for such purposes. Mr. Woods laid important stress on the necessity for precooling if the best results were to be obtained in actual transport service. The various systems of insulation were next described, and illustrated, and a typical example of the refrigerating machinery and equipment for a ship having holds with a total of about 310,000 cubic feet was given. The machinery described consisted of a Crossley-Premier oil engine driven ammonia compressor, with the brine distribution system. Air cooling systems were also described and illustrated. Finally, the author dealt with the modern equipment for an up-to-date passenger and fully refrigerated ship, and gave some figures for the operation of single and twin-screw ships, stressing the economy of the single-screw vessel. Other interesting sections of the paper included a description of a suggested method for the precooling of barges, the design of a coasting vessel for the transport of refrigerated produce, and the provision of suitable refrigerated railway rolling stock.

The paper is admirably illustrated, and it contains valuable information, alike for the designer, builder, and operators of refrigerated ships, barges, and railway wagons.

Discussion.

Dr. S. F. Dorey said the paper had behind it the authority of long and successful experience and indicated the prime importance of the safe carriage of refrigerated produce, upon which the welfare of a large proportion of the community depended. The enormous growth in the transportation of refrigerated produce overseas was well indicated by the figures given in the paper—developments in which the author had played a considerable part—and some records of Lloyd's Register were of interest in that connection. The inspection of refrigerating machinery and appliances started in 1898 and in the year 1900 63 vessels of just over 9 million cubic feet capacity held the Society's refrigeration certificate. To-day there were 530 vessels having a total capacity of 90 million cubic feet, which held that certificate. Realisation of the importance of hygiene in the preparation and handling of refrigerated produce had undoubtedly largely contributed to its successful transportation overseas. Recently one of the largest refrigerated vessels carried a consignment of chilled meat from Australia to the United Kingdom with the aid of CO_2 and discharged its cargo in excellent condition. The voyage occupied 32½ days, or, say, 40 days from the killing of the animals to the sale of the meat.

Under "air circulation and conditioning," the author referred to the danger of over-development of brown heart in apples when the temperature was maintained at the lowest point without freezing. He had been informed that apples had often been found on immature trees—under five years of age—suffering from brown heart, and it was obvious that those apples, although apparently sound when picked, would very rapidly develop the disease if kept in confined spaces. Referring to odour from citrus fruit, Dr. Dorey mentioned that the odour of oranges in a vessel would be disastrous if the next cargo consisted of butter, but the "Ozonair" system prevented that. The German "Bellefou-Folliot" system of freezing fish was particularly interesting, and if proved commercially sound would be a great advance on the present objectionable practice of carrying fish in boxes with ice and salt, because the boxes must be saturated with bacteria produced from repeated consignments of fish. Although the author had stated that 10 per cent. CO_2 or less appeared to be a convenient amount for the carriage of chilled meat on long voyages, he understood that the percentage had been reduced to 5 to 6 per cent.

On the question of the importance of pre-cooling of perishable commodities prior to shipment, it appeared desirable that that matter should be put on a proper basis. At present the shipowner had to provide power in excess of that required for the maintenance of the requisite temperatures during the voyage, because he might be called upon to deal with produce which had not been properly prepared for shipment. Dr. Dorey asked what insulation was used in the case quoted in the paper in connection with painting and preserving the ship's steel work and if the condition of the steel work varied with the different insulating material. As to leaving an air space between the ship's side and the insulation, did the author consider that that might provide means for odours arising from bilges to percolate into the insulation ?

The method of lining insulation with plywood panels, as suggested in the paper, had recently been adopted in several chambers in a London store where the insulation was cork slab and plywood sheets nailed to wood grounds. The vertical joints were covered by wall battens and the horizontal joints by wood strip, the whole surface being coated with aluminium paint. Cooling in that case was effected by air circulation over direct expansion batteries with finned coils and brine spray.

In connection with the reference in the paper to refrigerating machinery being driven by a direct-coupled heavy oil engine, Dr. Dorey said that the author was a pioneer in that direction. From reports so far received from surveyors to Lloyd's Register that type of drive had been most successful. Commenting on the modern practice of using main brine leads forward and aft from evaporator room to brine distribution houses, it was pointed out that one of the principal advantages, in addition to minimising heat losses, was the elimination of frequent troubles of brine leakages in batteries of leads passing through bunker spaces. It had been found that corrosion frequently took place, necessitating cutting out a number of the front rows of leads in order to get at defective leads behind. The long grid type of cooler through which air passes longitudinally is, in the opinion of Dr. Dorey, inefficient compared with the type having the grids across the air flow, the latter giving much more intimate contact between air stream and pipe surfaces. Finally, speaking of the pre-cooling of barges, the view was expressed that a great deal more could be done in that direction for the conveyance of refrigerated produce from shore to ship. At Gisborne, Australia, a dry battery air cooler had been installed on the wharf with suction and delivery connections to barges by means of flexible hoses. It appeared to be effectual and worth while in controlling the temperature of barges.

Mr. Sterry B. Freeman remarked that at present there was a very big pressure on refrigerated space in ships coming from Australia, which was due to a new orientation in respect of Empire trade. It was very disappointing when shipowners had provided tonnage at very considerable expense to carry refrigerated cargoes to find, in the first place, the Government putting on quotas which they knew nothing about, and, in the second place, to find that when a ship arrived in Australia there might be a waterside strike and the men would not load, so that cargoes could not be brought home. Nevertheless, the Australian trade was going on and was bound up with the quality of meat produced there as compared with that produced in other parts of the world.

Continuing, Mr. Freeman said he was thoroughly in agreement with the author as to the necessity for pre-cooling fruit before shipment. The troubles of the engineer would be minimised very considerably if that became standard practice and was carefully carried out. The loading of a huge quantity of fruit at orchard temperature into a restricted space such as a ship's hold was thoroughly unsound. The possibility of a good out-turn was further jeopardised by opening the hatches at subsequent ports and adding other consignments of hot fruit, and he knew of one compartment having been loaded at as many as six different ports. In the circumstances, the fact that the out-turn was as good as it usually was should be a matter for congratulation. Although the author referred to the use of a sterilising spray, he did not say what preparation he would recommend, and it would be interesting to know. He presumed that the reference to the "browning" of apples referred to "internal breakdown" and "scald." Many cargoes of apples had been carried under his supervision at a temperature of from 38 deg. to 40 deg. Fah., but latterly the growers had been leaving the fruit on the trees until the ripening process was very far advanced, and unfortunately a lower temperature had to be employed. As regards strawberries, Mr. Freeman said he had not had any experience and asked the author what could be considered the maximum length of life in cold storage. Commenting on the recommendation that an Ozonair plant should be installed where oranges are carried, Mr. Freeman said he had had personal experience of the effectiveness of ozone in removing the distinctive odour left by that type of fruit after the cargo had been discharged, but not when used during carriage. Could the author say whether the ripening of the fruit would be accelerated on a lengthy voyage, say, from Australia ?

There had been several very successful shipments of chilled beef from Australia in sealed compartments containing a concentration of 10 per cent. CO_2. In two of these shipments a small amount of oxygen had been injected into the compartment daily. Did the author think that ozone in large quantities would tend to oxidise the fat ? He believed that some experiments were being carried out at Cambridge in that connection, largely owing to the efforts of the author.

Speaking of insulation, Mr. Freeman said that, unfortunately, naval architects did not always keep the requirements of the refrigerating engineer in mind when designing the internal structure of a ship, and much space was lost owing to the generous insulation which had to be provided in order to cover completely the various obstructions.

Finally, remarking that one of the main developments of recent years in connection with refrigeration machinery was the adoption of heavy oil engines direct coupled to the compressors, it was suggested that the author must be gratified to see that type of prime mover—which he first instituted in the face of much opposition—now being adopted by another leader in the refrigerating world.

Mr. G. Dufour remarked that although the author spoke of the necessity for the wood sheathing of insulation to be gas-tight, he personally did not see the necessity for that for ordinary transport purposes. If, however, it was desired to make it gas-tight, a simple means consisted in inserting between the two layers of planks a kind of ruberoid paper. At the same time, that had distinct disadvantages, because if a wall was gas-tight it was also air-tight and dry rotting of the wood behind was unavoidable. A very good wall and ceiling covering for use with cork slabs was magnesia cement painted with an odourless paint. Little reference had been made to the much-debated question of floor insulation. Some people preferred the insulation to be underneath the decks, and others preferred it to be on top. Provided some precautions were taken to drain any possible leakage of water through the floor, he was rather in favour of the insulation being on top, but again he asked the author's experiences of cases—if any—where cargo had been spoiled or damaged through the proximity of an uncovered steel deck.

Although the system of bulkhead circulation, in the transport of bananas, referred to as the rotary system, was, in his view, the best, it was not necessary to use wooden bulkheads to direct the flow of air. A canvas hung underneath the deck and simply folded under the gratings was sufficient, and permitted of easy stowage of the cargo because it was only put in place after the corners and sides of the room had been loaded. With the rotary system, no air ducts being necessary, much space was gained and the quantity of air could be as large as required to ensure that each fruit was surrounded by the cooling medium. It was not necessary, however, to allow all the air to pass through the cooler ; it was sufficient that two-thirds of the total quantity be circulated by a special fan and mixed with one-third of cooled air. The most unsatisfactory part of a cooled air system was the ordinary type of pipe cooler, because it required periodical thawing, during which operation the temperature in the room could not be kept up, an important point for fruit generally, and bananas in particular. A better cooler was the contact type, in which the air and brine were first mixed—something like steam and water in a contact Weir's heater. When cooled, the air was dried to the desired extent. The advantages were that the air was deodorised and cleaned and the degree of moisture could be regulated as required. Moreover, the action of the cooler was continuous.

There was no time for further discussion and the author promised to make his reply in writing.

The meeting was then adjourned until Thursday morning.

The Annual Dinner.

The annual dinner of the Institution took place at the Connaught Rooms on Wednesday evening, April 10th, when the chair was taken by the President, the Right Hon. Lord Stonehaven. The toast of "The Institution of Naval Architects," was proposed by the principal guest of the evening, His Royal Highness the Duke of York. In the course of his speech the Duke said that he was pleased to meet so many captains in the shipbuilding industry, and he referred to his recent visits to the "Queen Mary" at Clydebank and to Barrow-in-Furness, where he had seen the "Strathmore" and "Orion," and the recently completed cruiser H.M.S. "Ajax." He wished success to the great branch of science represented by the shipbuilding and marine engineering industries. In responding to the toast, Lord Stonehaven said that work was increasing in the shipyards, and that nothing had been more welcome than the recent announcement of the First Lord of the Admiralty that he was gradually filling up the gaps in our naval defences which we had deliberately made in the hope that others would follow our example. The mastery of the sea was vital to us as a nation. The toast of "Ships" was given by the Right Hon. S. M. Bruce, the High Commissioner for the Commonwealth of Australia, who described the Royal Navy and the British mercantile marine as the great bulwark of the world's peace. In his reply, the Right Hon. Sir Bolton Eyres-Monsell, the First Lord of the Admiralty, spoke on the battleship, which, he stated, was considered by every serving sailor as the foundation of the defensive power of the British Navy. Referring to the experiments made by the United States Naval Authorities, and the more recent experience obtained in connection with the revolt in the Greek Navy, Sir Bolton stated that he considered the contention that bombing from the air had rendered the battleship obsolete was entirely disproved, and that the battleship of the future would be a veritable fortress of defence. Mr. L. C. Harris, the President of the Chamber of Shipping of the United Kingdom, also replied. The dinner was the largest in recent years, and about 600 members and guests were present. The new reception room arrangement at the Connaught Rooms was much appreciated, and afforded an opportunity for many members and guests to meet who would otherwise have found it difficult to foregather.

(To be continued.)

Aerodynamical Research and Hydraulic Practice.

On Friday evening, April 12th, Mr. A. Fage, of the Aerodynamics Department of the National Physical Laboratory, presented before the Institution of Mechanical Engineers a paper entitled "Aerodynamical Research and Hydraulic Practice." Mr. A. E. L. Chorlton, who occupied the chair in the absence of the President, explained that the paper represented an attempt to revive interest in hydraulic research in this country. It had been felt, he said, that some recent important developments in the field of hydraulics had been allowed to pass into Continental hands because of the decreased interest paid in this country to hydraulic research. Aeronautical research was fundamentally akin to hydraulic research and it had been argued that hydraulics could receive direct benefit from aeronautics if those interested in the two departments could be brought together. Mr. Fage's paper was designed to serve as a means to that end.

The meeting was thinly attended and the discussion which ensued produced little of general interest. The paper, ably written as it was, failed in large measure to realise its aim—to show that researches on fluid motion undertaken in aerodynamical laboratories have a useful bearing on problems of hydraulic practice. Mr. Fage made no claim to any experience of hydraulic practice and quite openly confessed that he had had great difficulty in discovering any actual examples illustrating the application of aerodynamics to hydraulics and in suggesting any directions in which such application might be attempted. He was obviously in a difficult position. It was not surprising to find that his paper was almost entirely of an aeronautical character, and that only at a few points and then but briefly did it touch upon hydraulics. As an exposition of certain modern developments in aeronautical theory and research the paper may be accorded much praise, but whatever value it may have in its effect on hydraulic practice will have to be extracted from it—laboriously and with much additional study—by those concerned with such practice.

The discussion, in a considerable degree, was of a reminiscent or historical character. Only one speaker, Mr. F. C. Johansen, seemed to us to make any contribution to it of technical interest germane to the real object of the paper. He suggested that some use might be made in connection with the flow of water in pipes of the general law revealed by aerodynamic research that the resistance of fluid motion at high Reynolds numbers was less than at low. Discussing the well-established relationship between heat transmission and the resistance to fluid motion he suggested that the transmission might be improved by the artificial introduction of turbulence in the heating or cooling fluid. Mr. Johansen went to the root of the real subject of the paper when he asked the author to state how far it was possible to investigate hydraulic problems by aeronautical methods. Taking advantage of the principle of dynamical similarity it might, he said, be convenient to carry out a research on a water propeller by means of a small-scale model tested in air. If the model were tested in water at the correct speed cavitation troubles would be encountered but in air there would be no cavitation. On the other hand, the air test might be rendered invalid by the entrance of the compressibility factor into the model results. One or two other speakers urged the desirability of aeronautics and hydraulics being regarded as branches of the same subject, but as to what extent and in what manner aeronautics should be introduced into courses of instruction designed for general engineering students—a question raised by Wing-Commander Cave-Brown-Cave—no opinion was forthcoming.

The present terminus of the former Midland Great Western Railway in Dublin is at Broadstone. By making a connection with the Drumconda Link line from the former Great Southern and Western Railway, the trains of the former system could use the Amiens-street station and so be connected with the Great Northern Railway (Ireland) and the line to Kingstown, Wicklow, and the south-east.

High-Pressure Marine Boilers.*

(*Concluded from page 395.*)

THE WAGNER-BAUER BOILER.

By O. JEBENS.

The construction of the Wagner-Bauer boiler is the result of endeavours to produce for marine engine plants of high economy a high-pressure boiler which combines highest efficiency with low weight, and offers reliable and most simple service as required on board ships. The experience and the results gained with the marine boilers known up till now have been carefully considered in every respect, and all complications which might form a source of trouble have been avoided.

From this point of view only water-tube boilers with drums could come into consideration, because only this type of boiler offers full safety as regards the mutual relations between the supply of fuel and feed water on one side and the consumption of steam at considerable variations of output, especially when manœuvring, on the other.

In order to obtain a short starting period of the boilers the water capacity has been reduced, but only to such a degree that all normal requirements can still be fulfilled with regard to variations of the water level when manœuvring, and to the necessary pureness of steam at full output.

Exhaustive trials with a small boiler as to the water circulation and the maximum evaporation have shown that the reduction of the water capacity by diminishing the drum diameters is justified, the smaller volume of steam at higher pressure—in the boilers so far built, 50–80 atmospheres—having a special influence.

Of course, the demand of simplicity in service as well as safety precluded an artificial circulation during service. Therefore an intensive natural circulation was aimed at by arranging the steam-raising tubes and the downcomers in the most suitable manner. Thus, it was arranged to lead the steam raising tubes into the upper boiler drum as near as possible to the mean water level and partly above it, while a nest of downcomers has been aranged at the underside of the upper drum. Also the tubes in the lower drum have been so arranged that the smallest possible alteration of flow from the downcomers to the steam-raising tubes is obtained.

In order to be sure that no steam bubbles are produced in the nest of downcomers, the superheater is arranged between the steam-raising tubes and the downcomers, the latter being dimensioned small enough to ensure that at the highest load of the boiler the production of steam bubbles in the first row of the downcomers is quite impossible. This is chiefly attained by the great drop of temperature of the heating gases between leaving the steam-raising tubes and entering the downcomers, this drop being achieved by the insertion of the superheater.

To ensure a sufficient cross section for the descending water, in spite of the considerable reduction of the number of downcomers (compared with former designs), the diameters of these have been increased. The diameters of the steam raising tubes are arranged according to the heat stress, and are therefore considerably smaller than those used up till now. A very good heat absorption in the steam raising tubes due to the better distribution of the heating surfaces, and reduced weight by diminishing the thickness of the walls and the water capacity, are thus obtained.

Special importance, of course, was attached to the necessity to enlarge as far as possible the portion of the total heating surface represented by the radiation heating surface. The following table gives the percentages of alteration of the different heating surfaces as compared with a boiler of one of the former types.

	Generating heating surface, m.²	Radiation heating surface, m.²	% of gen. heating surface, m.²
S.s. "Cobra" ..	375	16·5	4·4
S.s. "Hindenburg"	41	3·7	9·0
S.s. "Bremen" ..	1100	40	3·65

Due to the higher stresses, special steels of low-percentage alloy with high tensile strength and high yield point at working temperatures are used for the drums and the water tubes. The superheaters are generally so dimensioned that at normal service the temperature of the steam leaving the superheater does not exceed 470–480 deg. Cent. With regard to the chromium-molybdenum tubes of low-percentage alloy available, these tubes, having at 500 deg. Cent. a very good yield point and durability, are forge scale proof up to about 700 deg.

For normal marine engine plants no regulating devices for the superheater are provided, because it is designed for the highest load within its temperature range. When working with small loads the resulting drop of temperature of the superheated steam is low and must be taken into account. On the other hand, a guarantee is given that the highest temperature at full output will in no circumstances be exceeded and that no inadmissible heating of material can take place. Special value has been attached to the possibility of drawing out without trouble the whole superheater, or as far as possible the different elements. It has proved advantageous to arrange the lines of the superheater coils horizontally to avoid water pockets as far as possible.

As regards the arrangement of the water tubes around the furnace, one is not so unrestricted as with boilers having artificial circulation or forced circulation. The possibility of accommodating the Wagner-Bauer boiler without difficulty to meet all requirements arising from the different cross sections of the boiler-rooms being considered in any particular case, is clearly shown by the following illustrations. Fig. 30 represents a section through one of the water-tube boilers installed in two fast Customs cruisers. The

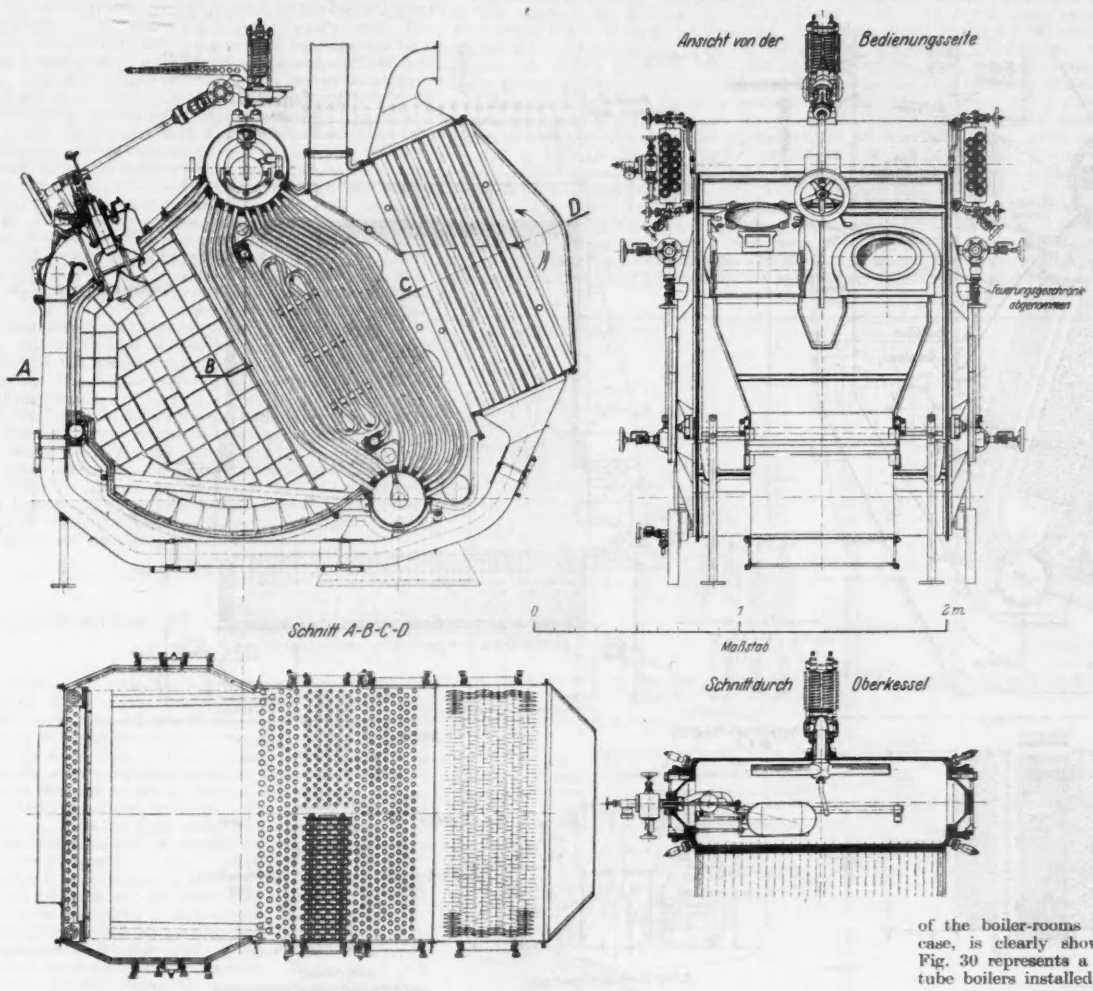


FIG. 30—*Section Through Wagner-Bauer Boiler.*

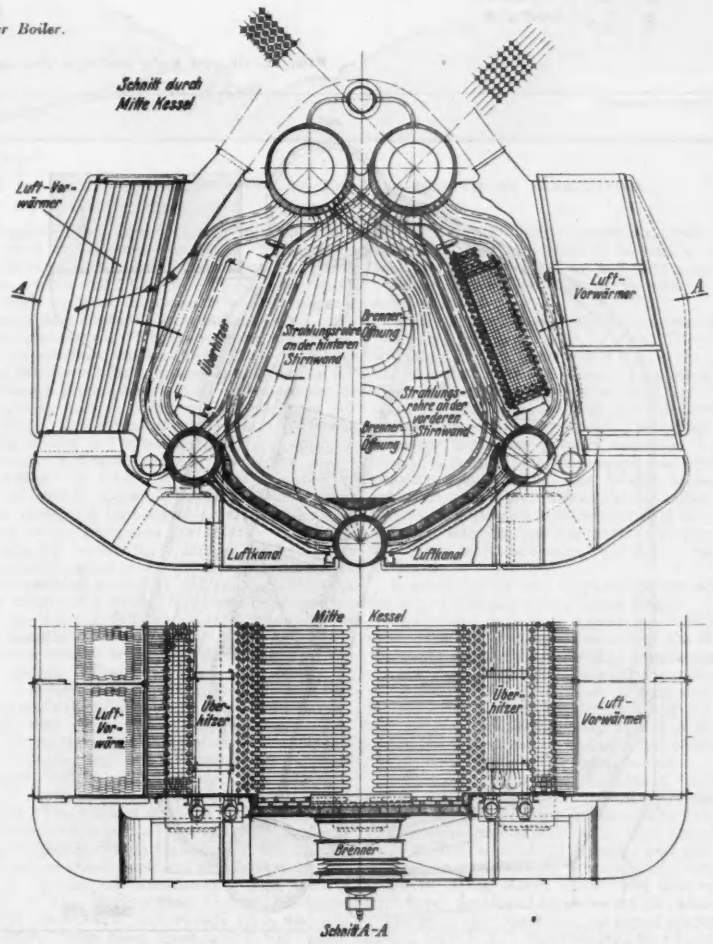


FIG. 31—*Special Type of Wagner-Bauer Boiler*

* Symposium, Institute of Marine Engineers, March 12th, 1935.

heat transmission surfaces are to be seen from the following table :—

Heating surface (water wetted)	50 m.²
Portion thereof of the radiation heating surface	6·3 per cent.
Superheating surface	13 m.²
Air preheating surface	80 m.²
Evaporation per hour	4000 kilos.
Steam pressure	50 atm.
Steam temperature behind superheater	480 deg. C.

Among these figures the high proportion of the radiation heating surface and the size of the air preheater are striking. The comparatively large radiation heating surface is the principal feature of the high-load boiler, and the air preheater serves to compensate the reduction of the downcomers and thus improves the general efficiency of the boiler. This is obtained by cooling down the exhaust gases in the air preheater to a remarkable extent. At the same time the furnace temperature is considerably increased by the highly preheated air, thus ensuring that by far the greater part of the heat in the furnace is already abstracted by the radiation tubes. In addition, it can be said generally that the weight of the air preheater is much lower than that of an equivalent feed-water preheater, which has to be under full pressure.

On vessels for special purposes—for instance, on the Customs cruiser referred to—corrosion-proof materials can be used. It will be possible to make the air preheating surface extremely thin (about 0·3 mm.), thereby obtaining very small weights. The total weight of the boiler ready for service, including the furnace lining of hollow brickwork and the water in the boiler, amounts in this case to

$$3 \cdot 2 \text{ tons, i.e., } 0 \cdot 8 \frac{\text{tons}}{\text{tons of steam per hour}}.$$

Fig. 32 represents one of two boilers now under construction for a fast passenger vessel. The dimensions of

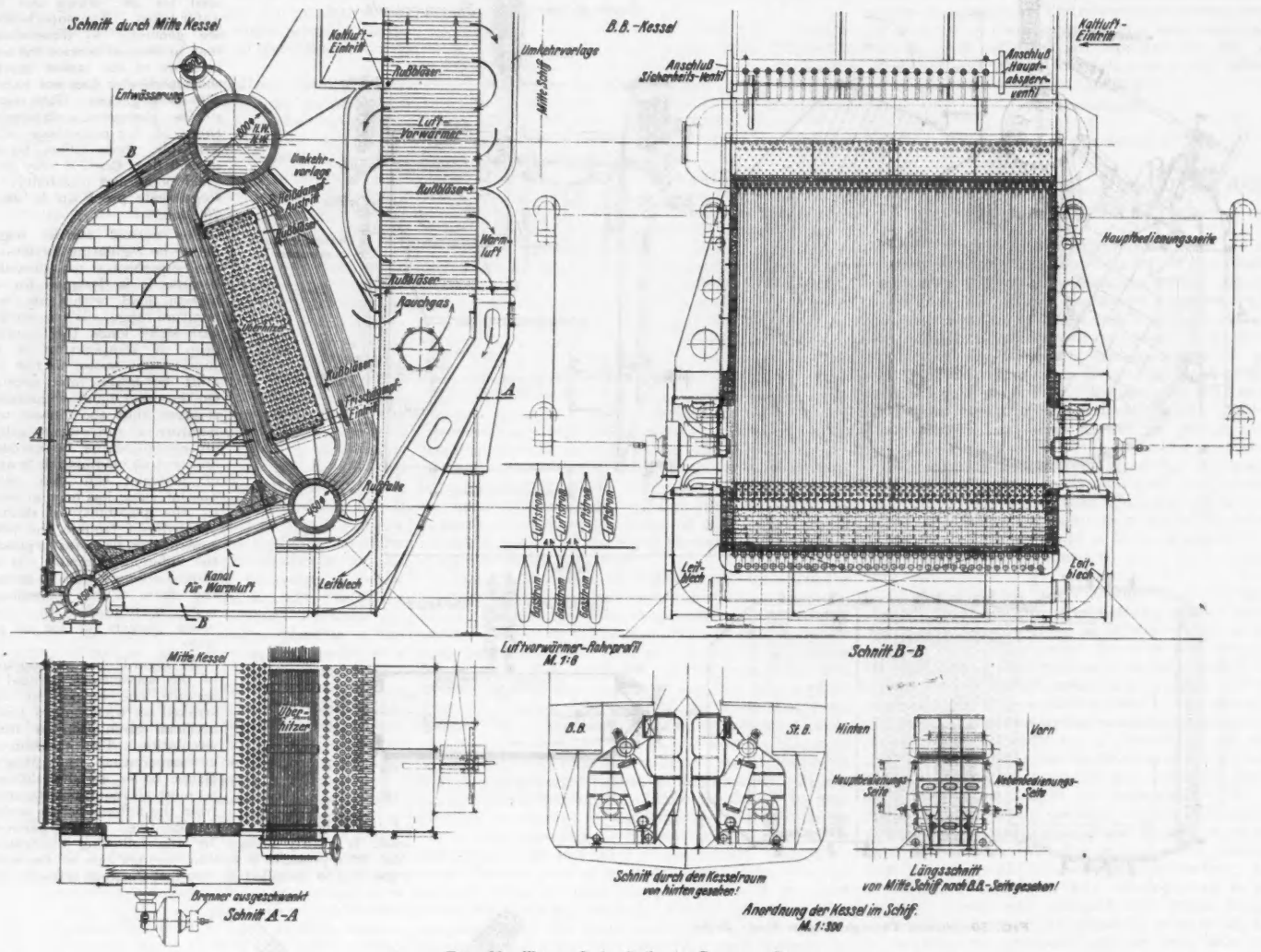


FIG. 32—*Wagner-Bauer Boiler for Passenger Steamer*

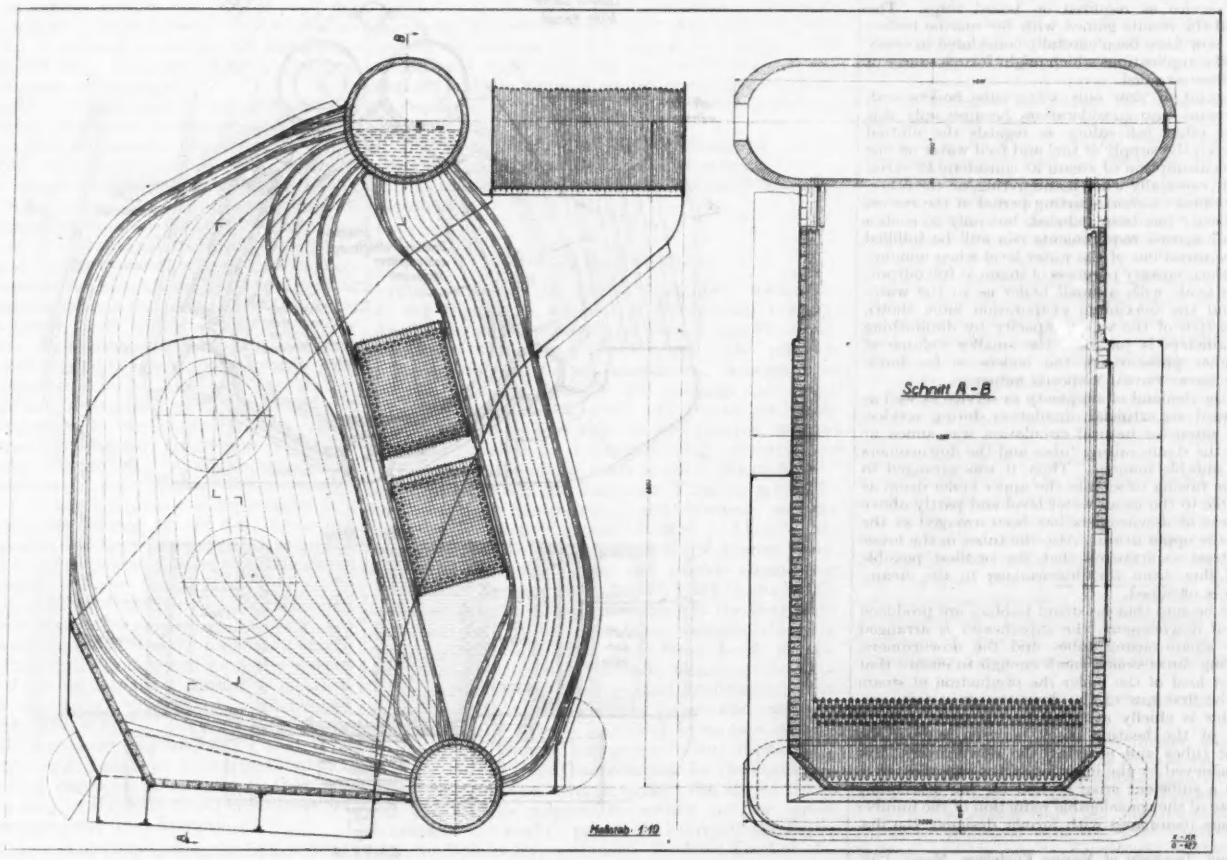


FIG. 33—*Wagner-Bauer Boiler for Large Passenger Ship.*

this normal boiler for a trading vessel are as follows :—

Heating surface	300 m.²
Portion thereof of the radiation heating surface	8 per cent.
Superheating surface	120 m.²
Air preheating surface	375 m.²
Evaporation per hour	25,000 kilos.
Steam pressure	60 atm.
Steam temperature behind superheater	480 deg. C.

In this case no special efforts have been made to reduce the weight of the boiler. Nevertheless, it amounts (ready for service) to about 40 tons, *i.e.*, about 1·6 tons per ton of steam produced.

The boiler for a vessel of special type is represented by Fig. 31, which gives a good indication of the boiler's great adaptability to the space conditions in every case. The boiler is of extremely light construction and designed for a steam pressure of 80 atm. and a temperature of 480 deg. Cent. The unit weight is 0·7 ton per ton of steam produced per hour. This type of boiler is characterised by its extraordinary insensibility to impurities in the water, mechanical admixtures, salt, &c., for instance. If in case of stronger concentrations of salt or lye the boiler is priming, an entrainment of these impurities into the main steam piping is avoided. Fig. 33 shows one of the boilers at present under construction for a big fast passenger vessel. The heating surface of each of these boilers is 650 square metres. The same principles of construction as mentioned before are to be recognised.

Finally, it may also be pointed out that the most suitable design of the fittings contributes to the good working of the boiler. In this connection the newly developed feed regulator is worth mentioning. It actuates the regulating valve through a diaphragm before the level is lowered, if the steam consumption is more or less considerable. The floater serves only to correct the working of the diaphragm.

All other details, for instance, manhole covers, &c., are also constructed in accordance with modern points of view, as necessary for the increased working pressures.

To sum up, it can be said that, systematically using all experience gained up till now, the Wagner-Bauer boiler represents a new type which answers to the fullest extent all requirements of marine service as regards safety of working and simplicity of attendance.

Electrification of Central Railway of Brazil.

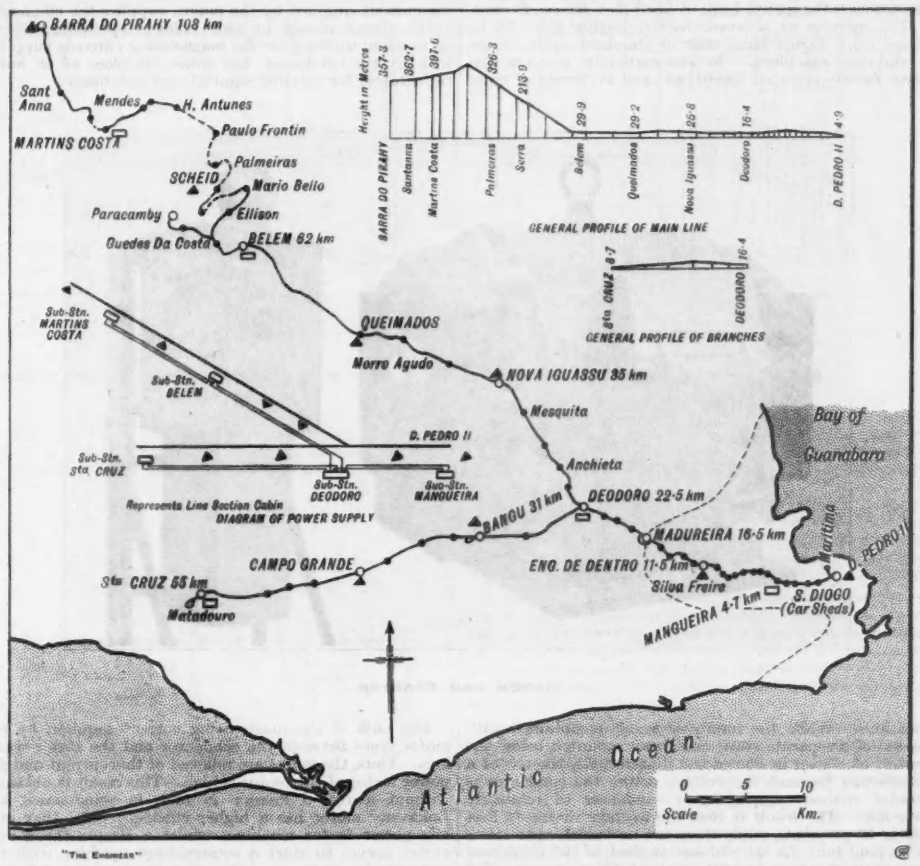
On March 14th, 1935, the contract for the electrification of certain lines of the Central Railway of Brazil was formally signed by officials of the Brazilian Government and the Metropolitan-Vickers Company. This contract comprises main line and suburban electrification from Rio de Janeiro, extending as far as Barra do Pirahy on the main line and to Santa Cruz on the Mangaritiba line, which branches from Deodoro. The branch line from Guedes da Costa to Paracamby will also be electrified. The electrification will be carried out with the 3000-volt D.C. system, similar to the Paulista Railway in Brazil and other systems throughout the world. Current collection will be from an overhead wire system. The total route to be electrified is 147 kiloms., mostly double or quadruple track, and the general plan of the railway, with the positions of the sub-stations and railway stations, is shown on the accompanying diagram. The contract will be divided into two stages, the first covering the suburban system, terminating at Nova Iguassu on the main line and Bangu on the Santa Cruz line, and including car sheds, workshops and offices. The second stage of the electrification extends on the main line up to Barra do Pirahy and to Santa Cruz and Paracamby on the branch lines.

It is the ultimate intention to take a supply of power at 80-kV, three-phase, 50 periods, at a main step-down station at Deodoro, which is the centre of energy distribution, where it is transformed to 44 kV for distribution to five sub-stations, but for the purpose of the first stage power at 25 kV, three-phase, 50 periods will be fed direct to sub-stations Nos. 1 and 2, the equipments being so designed as to connect for either 25 kV or 44 kV. The main step-down station is of the outdoor type, and consists of three transformer units, each of 17,500 kVA, with the corresponding 80 kV and 44 kV switchgear apparatus, it being the intention that one of these units shall serve as a standby. These transformers feed into the 44-kV bus-bar, from which circuit breakers control three outgoing double circuit transmission lines, following the railway route and feeding their respective sub-stations. Deodoro sub-station also takes its power from this bus-bar. The sub-stations thus supplied with power are to be at Mangueira, Deodoro, Belem, Martins Costa, and Santa Cruz, numbered respectively 1, 2, 3, 4, and 5. The first four will each be equipped with three 2500-kW rectifier units, one being normally in reserve, while No. 5 will have only two such units, one of which is again normally in reserve. The converter apparatus comprising steel tank mercury arc rectifiers with their transformers convert the incoming 44-kV A.C. to 3000 volts D.C. This converter apparatus is complete with all the necessary auxiliary equipment, which takes power from either one or other of a pair of auxiliary transformers, the switches being suitably interlocked. The rectifiers are equipped with separate re-coolers for the main circulating water, and the D.C. output is smoothed by the use of resonate shunts and condensers which minimise interference with communication circuits. The sub-stations are arranged with outdoor type rectifier transformers, auxiliary transformers and 44-kV switchgear, whilst the rectifiers and control equipment are housed inside the building. The rectifiers supply power to the D.C. bus-bar, each equipment being protected with a reverse current high-speed circuit breaker. The trolley wire is fed from the 3000-volt D.C. bus-bar through high-speed circuit breakers, which also serve to sectionalise the line at that point. The line is further sectionalised at various points between sub-stations by track section cabins, containing high-speed circuit breakers. The complete scheme comprises metering equipment at the Deodoro main step-down sub-station, which will enable records to be made of the total power consumed by the system. The equipment also provides for measuring the power input to each individual sub-station.

For the purpose of supplying signalling power to the system, duplicate 44-kV/4400-volt, single-phase, 50-period step-down transformers, one of which is a standby, are installed at every sub-station. The transformer feeds the 4400-volt single-phase overhead transmission line, which is tapped where required and connected to pole-mounted transformers to reduce the pressure to 110 volts for signal purposes.

The energy supplied to the system, as well as the operation of all A.C. circuit breakers, rectifying apparatus and D.C. feeder and sectioning breakers will be remote supervisorily controlled from a separate control room situated adjacent to the Deodoro sub-station.

The overhead construction provides for the equipment of 334 single-track kilometres. The railway between Dom Pedro II and Deodoro has four and six main running tracks, and runs through a thickly populated area. From Deodoro to Belem there are two main running tracks. From Belem to Barra do Pirahy there is a Serra section with two tracks through tunnels, cuttings and embankments, with severe gradients and curves of a minimum radius of 140 m. The overhead equipment for all lines consists of a single grooved copper contact wire of 125 square millimetres section, suspended by means of flexible droppers from a single catenary wire, which is copper for main running tracks and galvanised steel for secondary lines. The total copper section, including messenger wire, will be 225 square millimetres per track from Dom Pedro II to Deodoro ; from Deodoro to Barra do Pirahy and to Santa Cruz it will be 250 square millimetres. The



CENTRAL RAILWAY OF BRAZIL—LINES TO BE ELECTRIFIED

catenary is supported by means of disc insulators suspended from steel supporting structures. The contact wire is registered at structures by means of short register arms carried on a cross span, and on sharp curves a "pull-off" from a single mast at mid-span is used to register both the catenary and contact wires, instead of an additional supporting structure. The supporting structures, in addition to the overhead track equipment, carry, where required, a double-circuit three-phase supply at 44 kV to the sub-stations, a single-phase 4·4-kV power supply for signalling purposes, and a continuous earth wire for structure bonding. The catenary and contact wires are rigidly anchored at each end of tension lengths of approximately 1·6 kiloms. On main running tracks the equipment is "sectioned" by means of switches mounted on the structures at overlap spans, at the end of the tension length, and by means of high-speed circuit breakers in track-sectioning cabins alongside the track. For cross-overs and sidings, the sectioning is carried out by means of section insulators inserted in the overhead line and controlled by hand-operated switches. All rails of the track are bonded by means of a welded type rail bond welded to the sides of the running rails and cross bonds between tracks are also installed.

All the suburban electric trains will be operated on the multiple unit system. Train units to the number of seventy-eight, each consisting of one motor car and two driving trailer cars, will be provided. Sixty will be furnished with the first stage of the electrification. The trains can be run as three, six or nine-coach trains, but generally it is expected that six-car trains will be used. Each motor coach will be equipped with four 175 h.p. motors which are of the self-ventilating type and provided with field control. The normal make-up of the train is a motor coach in the middle and a driving trailer coach at each end, the train being driven from one of the driving trailers, but the motor coach itself will also have a driving cab for use in special circumstances. The control equipment will be the Metropolitan-Vickers Electrical Company's electro-pneumatic unit switch type, and will be housed in switch group cases fixed under the coach. Series parallel control with bridge transition with full automatic acceleration will be provided. The coaches are of steel construction and will be non-compartment stock ; first and second-class coaches will be provided, the first-class having sixty-eight seats and the second-class seventy-two seats. Each motor coach will be provided with two pantagraph collectors on the roof, only one of which will normally be in use in service. The trains will be operated at an acceleration of about 1·8 kilom. per hour per second in order to maintain a reasonably high schedule speed with the short distances between stations in the suburban area, and will run at about 70 kiloms. per hour on level track.

Nine passenger locomotives will be provided of the 2–6–6–2 type, weighing 130 tons in working order, and having a total rating of 2862 h.p. for one hour and 2340 h.p. continuous. These locomotives are equipped with with six axle-mounted motors, each of 477 h.p., arranged for field control and for three different strengths of field. As there will be three different motor combinations, giving one-third, two-thirds, and full speed, each with three field strengths, there are nine different economical speeds available. The passenger locomotives are of the double-bogie type, with articulated coupling between bogies, and each bogie is provided with a pony truck. The maximum service speed is 90 kiloms. per hour on the more level parts of the railway, with a considerably reduced speed over the Serra gradients. The control will be of the electro-pneumatic type, and the locomotive will be provided with regeneration to control the speed going down the Serras, where heavy gradients are encountered. The maximum weight of passenger train to be hauled will be 500 tons, and one locomotive is to pull this train over the level portion and also over the Serra without assistance from another locomotive.

There will be fifteen freight locomotives of the 0–4–4–0 type, each weighing about 76 tons. They will be equipped with four motors, each of 395 h.p., and the total power of the locomotive at the one-hour rating will be 1580 h.p. The continuous rating will be 1320 h.p. The motors will be of the axle-mounted type, provided with field control, giving three different speeds, and the control will be arranged for series parallel operation for half and full speed, giving in all six economical speeds. Like the passenger locomotive, the freight locomotives will be provided with regenerative braking. The maximum train weight to be hauled is 1000 tons, and this will be handled as far as Belem by one locomotive and beyond Belem over the Serra by two locomotives driven from the leading locomotive.

In addition to these, there will be six small locomotives for mixed passenger and freight trains.

The power signalling installation will consist of both controlled and automatic sections. On the first stage of the contract, all-electric locking frames controlling power-operated points and signals will be installed at four of the principal stations. At other stations mechanical locking frames will be used, the levers being electrically locked and controlling mechanically operated points and shunt signals, but electric main line signals. Automatic signalling will be installed between signal cabins.

Throughout the system A.C. track circuits, using vane relays, will be employed. Generally, double rail track circuits using impedance bonds will be fitted.

The main three-aspect colour light signals will be of the most modern searchlight pattern, and many of them will operate in conjunction with electric train stops. The majority of the shunt signals will also be of the colour light type, controlled from the signal cabins.

The power for operating the signal system will be taken from a 4400-V A.C. line running along the side of the track supported on the overhead structures, and this supply

will be stepped down to 110 V at each signal cabin and location.

The car sheds and office buildings will be at Sao Diogo, not far from Dom Pedro II, and the repair sheds at Deodoro.

The principal firms sub-contracting to Metropolitan-Vickers will be :—

(1) British Insulated Cables, Ltd., for overhead line and transmission.

(2) The British Thomson-Houston Company, Ltd., Rugby, for the rectifier units and the high-speed circuit breakers.

(3) General Railway Signal Company, London, for the signalling installation, for whom Metropolitan-Vickers manufacture the apparatus.

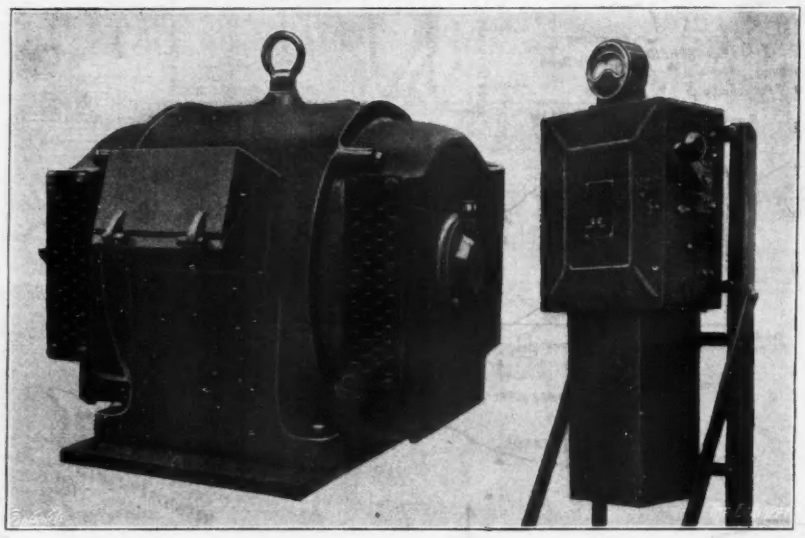
(4) Metropolitan Cammell Carriage and Wagon Company, Ltd., for the coach bodiesand trucks.

In addition, building contracts are being placed locally in Rio de Janeiro.

The work to be begun immediately on this contract will comprise all that is included and described as coming under the first stage, and this portion will extend over a delivery and installation period of about 2½ years.

The Lokaveay Induction Motor.

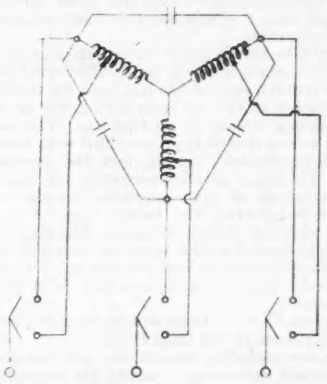
The Lokaveay motor introduced by the Electric Construction Company, Ltd., of Shell-Mex House, Strand, W.C.2, operates at a power factor roughly from 10 to 25 per cent. higher than that of standard squirrel-cage or slip ring machines. It automatically corrects the power factor under all conditions, and is devoid of com-



Motor and Starter

plications. While the improved result is obtained with the aid of a separate static condenser mounted below the starter, as shown in one of the illustrations, the use of a transformer to raise the voltage across the condenser is avoided without employing a condenser of relatively large size. The result is that the average saving in first cost is 10 per cent., while there are no transformer losses to be paid for. As the voltage applied to the condenser varies with the strength of the motor field, the magnetising current supplied by the condenser increases at reduced loads and maintains a high power factor.

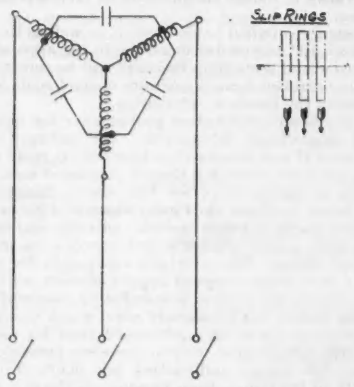
Although the stator winding is of standard type, it can be wholly or partly excited by the condenser. One



Connections for 600-Volt Condenser

of the diagrams shows the stator winding of a 400 volt motor, but wound for 600 volts to suit the condenser, the mains being connected to 400 volt tappings. Thus, the winding serves as an auto transformer for raising the condenser voltage while the machine is running. When starting a change-over switch connects the mains to the condenser terminals, with the result that the number of turns connected to the supply is increased by 50 per cent., and the motor field is reduced to two-thirds of its normal value. The effect produced is the same as that obtained by the use of an auto-transformer with a step-down ratio of 3 to 2.

For slip-ring motors or squirrel-cage machines arranged for direct starting, the same winding may be used without a change-over switch, but in certain cases the winding shown in the second diagram may be used. The winding is provided in this case with tappings for connection to a 300-volt condenser, the normal 400-volt winding thus serving in this case as a step-down auto-transformer. The winding serves four distinct purposes ; it carries



Connections for 300-Volt Condenser

the current supplied by the mains, supplies the condenser at the correct voltage for most efficient operation, acts as an exciting winding for the magnetising currents supplied to it by the condenser, and takes the place of an auto-transformer for starting squirrel-cage machines.

The bulk of the magnetising current required by the motor flows between the condenser and the stator windings. Thus, the mains are relieved of this current and the power factor of the motor is high. This result is obtained without increased losses ; in fact, in some cases, the Lokaveay motor has a higher efficiency than that of a low power factor machine, whilst a simple throw-over switch serves to start a squirrel-cage machine with the same readiness as an ordinary squirrel-cage motor with an auto-transformer. Owing to the elimination of the magnetising current needed by an auto-transformer the starting power factor is raised.

Thawing-in Cylinder Liners.

The process of reducing the diameter of oversized liners by subjecting them to very low temperatures so that they will expand again at normal temperatures and bind in place in their jackets, is familiar to most engineers, although the practice is not yet very widespread. It is, of course, the reverse of the old-established process of shrinking on. The accompanying picture, which has been sent to us by the British Oxygen Company, Ltd., of Victoria Station House, Westminster, illustrates the modern process. It represents the lining of a six-cylinder motor block at the A.E.C. works, with the assistance of liquid oxygen from the Wembley works of the British Oxygen Company. The cylinders in question are 5½in. in diameter by 10½in. stroke, and the liner is about ⅛in. thick. The liners are made two one-thousandths of an inch large in outside diameter at room temperature.

The method employed for inserting the liners is as follows :—

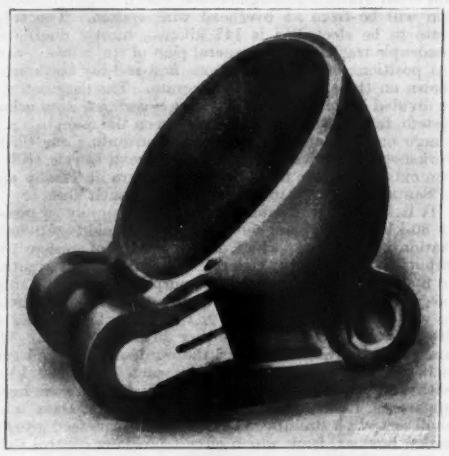
A zinc container is made which will hold two sleeves. This container is completely surrounded with about 9in. thickness of insulating material, and a cover is arranged, also heavily insulated, which is hinged to facilitate rapid removal of the sleeves. Some 5 gallons of liquid oxygen are required to cool it, but once cool the internal container is nearly full of liquid oxygen at about —183 deg. Cent. The operator, wearing rubber gloves, quickly immerses in the liquid oxygen two sleeves, closes the lid, and times the cooling by stop watch. At the end of sixty seconds he opens the lid quickly, lifts out one sleeve and drops it into the cylinder block, then follows the second sleeve. Two more sleeves are now immersed in the liquid, whose level has been made up to normal by the addition of fresh liquid from the source of supply, and after sixty seconds these are dropped into position, and so on. Recently a complete novice fitted twenty-four sleeves in three-quarters of an hour by this method, using 5 gallons of liquid oxygen to make up evaporation losses. The importance of the process, it is said, does not lie in

Thawing-in Cylinder Liner

the saving of labour, but in the fact that the manufacturer or repairer is absolutely certain of getting a 100 per cent. job.

The Blackie Self-Locking Dredger Bucket Pin.

The pins which are usually employed to connect together the buckets of ladder dredgers have L-shaped heads to prevent them from turning in the eyes. In time the L wears slack in its recess in the cheek and allows the pin to rock. With the Blackie pin, which is made by Hadfields, Ltd., of Sheffield, this trouble is overcome. The L-shaped style of head is retained, but, as is shown in the accompanying engraving, it is splayed out and is



Dredger Bucket and Locking Pin

split to give it a certain amount of resilience. It is also dovetailed in its thickness and the groove is correspondingly undercut. In order to allow the pin to be put in place the holes in the bucket lugs are slightly oval, so that the pin can be pushed back to clear the dovetail on the L head. Then the tension in the chain of buckets jams the pin in place and prevents any looseness. It is said that these pins have never shown any signs of looseness even after prolonged service.

BOOKS RECEIVED.

Principles of Phase Diagrams. By J. S. Marsh. London : McGraw Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 18s. net.

Report of the Fourth Public Health Congress and Exhibition, 1934. London : The Congress Organising Council, 13, Victoria-street, S.W.1.

Modern Heavy Oil Engines Simply Explained. By B. Way. London : Percival Marshall and Co., Ltd., 13/16, Fisher-street, W.C.1. Price 5s. net.

The Natural Logarithm. By Sir C. Vernon Boys, A.R.S.M., LL.D. London : Wightman and Co., Ltd., Regency-street, S.W.1. Price 2s. net.

Shellac : Its Production, Manufacture, Chemistry, Analysis, Commerce, and Uses. By E. J. Parry, B.Sc. London : Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 12s. 6d. net.

Launch of the Quadruple-Screw Turbine Steamer Queen Mary.*

By J. M. McNEILL, B.Sc.

In presenting this paper on the launch of the Cunard White Star liner "Queen Mary," an endeavour has been made to relate, in their proper sequences, the events which led up to its successful culmination on September 26th of last year. The vessel represented the largest weight of its kind ever set in motion, yet she was safely launched and under control in approximately 100 sec. from the moment of her release. The apparent ease with which this was accomplished gave little indication of the precautions taken to ensure that the whole operation should be entirely successful, and in what follows is given a brief summary of the preliminaries incidental to the undertaking as well as a record of the observations made on the launch itself.

The first study of the calculations was made exactly five years ago, when the tender for the construction of which the "Aquitania" was built, and which was eminently suitable in declivity and make-up of ground. The foundations of this berth had been amply proved as being capable of withstanding the heavy pressures at the river end, while the transverse spacing of the reinforcement conformed closely to the most desirable dimensions to accommodate the structure in the main lines of strength.

Launching Experiments.

As successful launching of very large vessels on the Clyde is inseparably bound up with the choice of most suitable tide periods, a particular study was made of local tidal behaviour to ensure the selection of the most favourable date. From the observations made it was evident that, even allowing for unfavourable weather conditions and for the advanced time of launch necessary for controlling the movements of the vessel after she was afloat, a sufficient depth of water on the way-ends would be available. This prediction of 8ft. gave a satisfactory margin of about 6in. over the minimum safe launching depth determined from other considerations; but while we were primarily concerned with minimum tides, we hardly expected to be favoured with the abnormally high tide which occurred, yielding a depth of water of 11ft. 6in. This gives adequate proof of the extreme variations which had to be legislated for, not only in the calculations, but also in the structural arrangements made. A full account is given of the results of the launching experiments. The most important factors affecting the vessel's safety were the estimates of the distance which she would travel after leaving the ways and the exact path of the stern. As these considerations determined the amount of dredging necessary, and had a direct bearing on the economics of the undertaking, it is interesting to note that the observations made in this connection led to the following deductions.

Stern Lift.—Over the whole range of the systematic variations of the standard condition, the experimental point of stern lift agreed very closely with the static stern lift as calculated in the usual manner.

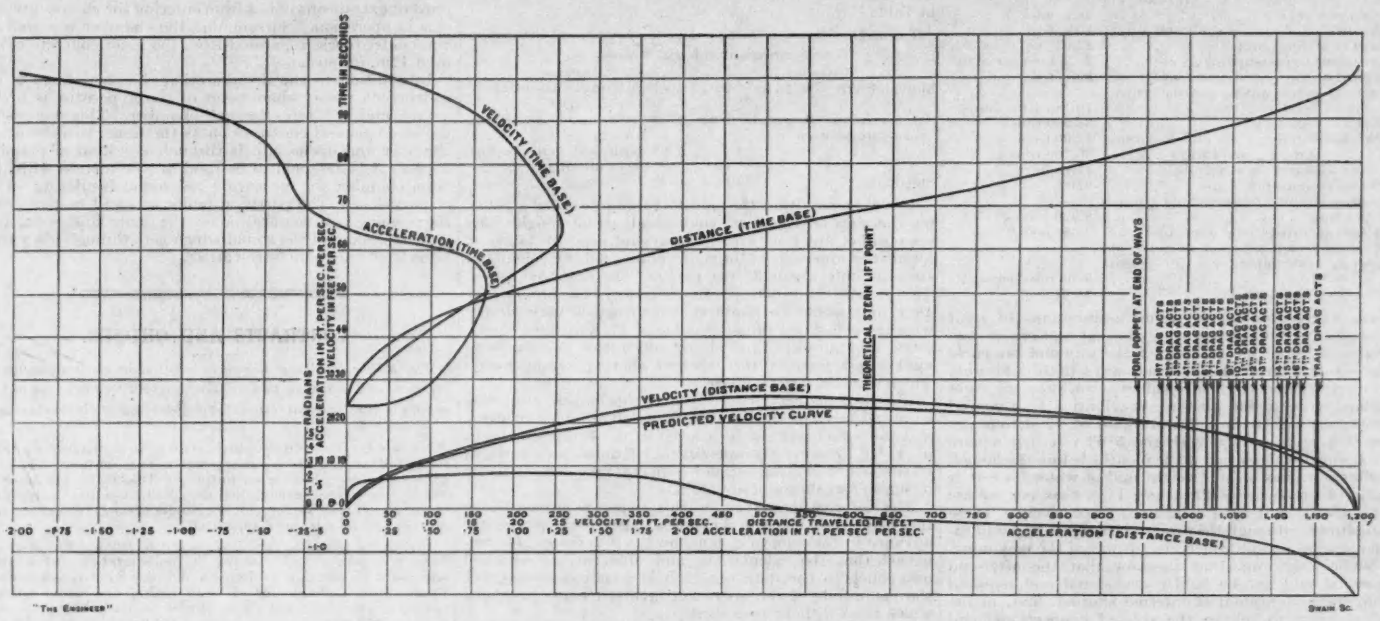


FIG. 1—TIME DISTANCE RECORDS AND VELOCITY AND ACCELERATION RECORDS

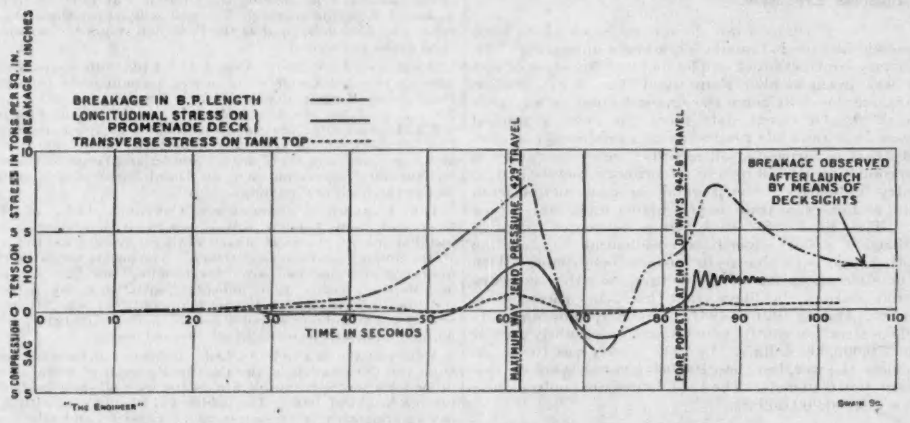

BREAKAGE IN B.P. LENGTH
LONGITUDINAL STRESS ON PROMENADE DECK
TRANSVERSE STRESS ON TANK TOP
BREAKAGE OBSERVED AFTER LAUNCH BY MEANS OF DECK SIGHTS
MAXIMUM WAY-END PRESSURE 429' TRAVEL
FORE POPPET AT END OF WAYS 843'-6" TRAVEL
TIME IN SECONDS
"THE ENGINEER"
SWAIN Sc.

FIG. 2—FORCES ACTING ON THE SHIP DURING LAUNCH

Water Resistance.—It was noted that the water resistance is a more important factor in the estimate of travel than the influence of the drag weights, and it was thought reasonable to express this resistance as a function of $(\text{Buoyancy})^{\frac{2}{3}}$, a coefficient being derived which yielded a satisfactory solution of the total water resistance related to velocity.

Distance Travelled.—From the data obtained it was thus found possible to build up a complete energy equation, and by using the appropriate coefficients to obtain a velocity-distance curve covering the whole range of movement.

In the accompanying Table I, a full statement of dimensions, declivities, and pressures is given, the outstanding figure in this list being the total launching weight of 36,700 tons. This weight induced abnormal pressures on the triggers, six in number, which had to be specially designed and constructed, with ample factors of safety to withstand the loads for a considerable time before the vessel was released. This was particularly essential in view of the elaborate arrangements which had to be made in connection with the Royal visit.

Fore-Poppets.—As the poppets, when the stern lifted, had to take a pressure of 8000 to 9000 tons, a load far in excess of anything previously experienced, the design and structure were carefully studied in comparison with alternative methods, and a full description is given of the arrangements ultimately evolved and the tests carried out on materials.

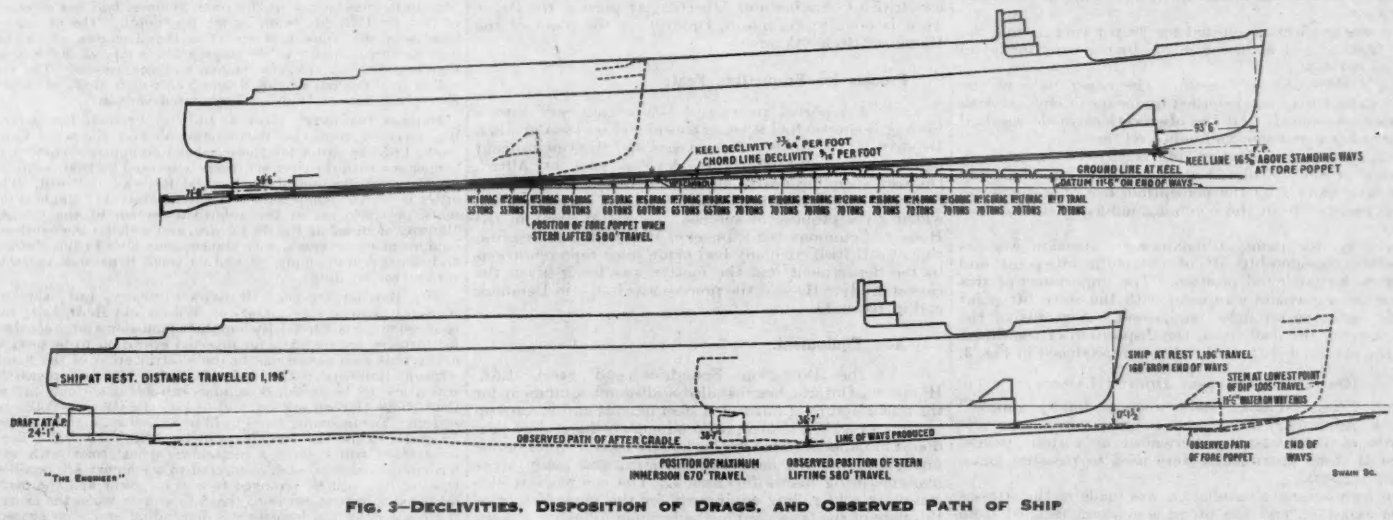

KEEL DECLIVITY 23/64" PER FOOT
CHORD LINE DECLIVITY 3/16" PER FOOT
KEEL LINE 16½" ABOVE STANDING WAYS AT FORE POPPET
GROUND LINE AT KEEL
DATUM 11'-6" ON END OF WAYS
POSITION OF FORE POPPET WHEN STERN LIFTED 580' TRAVEL
SHIP AT REST. DISTANCE TRAVELLED 1,196'
SHIP AT REST 1,196' TRAVEL 168' FROM END OF WAYS
STERN AT LOWEST POINT OF DIP 1005' TRAVEL
OBSERVED PATH OF AFTER CRADLE
LINE OF WAYS PRODUCED
POSITION OF MAXIMUM IMMERSION 670' TRAVEL
OBSERVED POSITION OF STERN LIFTING 580' TRAVEL
OBSERVED PATH OF FORE POPPET
END OF WAYS
"THE ENGINEER"
SWAIN Sc.

FIG. 3—DECLIVITIES, DISPOSITION OF DRAGS, AND OBSERVED PATH OF SHIP

* Summary of paper read before Institution of Naval Architects.

Pressure on After-end of Ways.—The pressure on the after-end of the ways of approximately 5 tons per square foot was of very moderate amount, but at an earlier stage of construction, and with a more normal tide, it was estimated that it would be considerably exceeded. This

TABLE I.—*Launch Particulars (as for Actual Launch).*

Declivity of keel of ship	33/64in. per ft.
Declivity of chord of standing ways	1/8 in. per ft.
Length of standing ways	942ft. 6in.
Camber of standing ways	18in.
After-perpendicular from aft end of standing ways	71ft.
Fore-perpendicular from fore end of standing ways (fore-poppet)	93ft. 6in.
Length of sliding ways	813ft.
After-perpendicular to aft end of sliding ways	58ft. 6in.
Breadth of sliding ways (each way)	10ft. 6in.
Area of sliding surface	17,073 sq. ft.
Initial mean pressure on grease	2·15 tons per sq. ft.
Spread of ways (centre to centre)	29ft. 6in.
Inclination of ways towards centre line of berth	1in. in 10ft. 6in.
Weight of ship	35,500 tons
Weight of sliding ways and make-up	1,200 tons
Total weight on ground ways	36,700 tons
Depth of water on way-ends	11ft. 6in.
Travel at stern lift	629ft.
Corresponding pressure on fore-poppets	8,325 tons
Minimum anti-tipping moment	2,380,000ft.-tons
Maximum pressure over aft end of ways calculated as for rigid structure	5·03 tons per sq. ft.
Corresponding travel	439ft.

pressure was based on the usual assumptions of rigid ways and rigid hull, but during the calculations it was decided to attempt an estimate of the way-end pressures on the assumption of the hull and ways both deforming in an elastic manner. The result was to alter the rigid conditions straight line pressure distribution to a curved pressure line with a way-end ordinate of 17·6 tons per square foot as compared with the 5·03 tons per square foot. A similar calculation made months before the launch for different values of hull weight and of water on end of ways, gave pressures of 22·8 and 14·8 tons per square foot for elastic and rigid conditions respectively. These investigations, although they might be subject to modification for several factors which are left out of the reckoning, were sufficiently important to show that the after-end pressures should not be lightly considered and required a comprehensive system of internal shoring, first, in the double bottom to relieve the riveted connections, and secondly, above the double bottom to transmit the pressures into the upper structure. The steel shoring fitted up to the first deck girder, which came conveniently in line with the ways, took the form of columns of A shape every, three frame spaces apart, straddling the line of ways at their lower ends.

Chain Drags.—Estimates of the time-velocity-distance values led to the determination of the chain drags required to stop the vessel and gave a total of 2350 tons. It was arranged that the first drag should come into action when the fore poppet had passed the end of the ways by 20ft.

OBSERVATION RECORDS.

The observations carried out, with a view to obtaining the records of the main technical features, were arranged on an extensive scale and made provision for cross checking by independent instruments and *personnel*. This applied particularly to the time-distance record, which is given in Fig. 1, together with the velocity and acceleration curves derived from it. In this same diagram, plotted on a base of travel, is shown a curve of predicted velocity for comparison, the coefficients used in this curve being the values deduced from the experiments. It will be seen that the estimated total travel was 1194ft., while the observed actual total travel, which was also checked by drag movements, was 1196ft. This degree of coincidence, however, may be somewhat accidental, but from the approximate agreement between the two velocity curves throughout their lengths, it is claimed that the values determined for the various resistance coefficients must have been closely realised during the actual launch. A further development of this is shown in Fig. 2, which shows a curve of the forces acting on the ship during the descent. As the component of the weight of the vessel down the ways is resisted by the sliding friction, water resistance, and drags, it is interesting to note the relative amount of these forces.

The ways' friction made up 54 per cent. of the total resistance.

The water effect accounted for 29 per cent., while the drag friction and acceleration of drag groups made up only 17 per cent.

Ship's Path During Launch.—The exact path of the vessel in its travel was recorded by means of cine cameras suitably positioned. All the observations made resulted in very close agreement and indicated that :

First, the point of stern lift occurred somewhat in advance of the calculated static point ; but this may have been caused by the perceptible rise of water level, which resulted from the confining influence of the river banks.

Secondly, the point of maximum immersion was, as expected, considerably aft of the stern lift point and closer to its predicted position. The importance of this maximum immersion compared with the stern lift point should again be strongly emphasised. A profile of the ship showing the declivities, the disposition of the drags, and the observed path of the ship is reproduced in Fig. 3.

RECORD OF STRESSES DURING Llaunch.

Four Fereday-Palmer stress meters, kindly supplied by the Admiralty, were used to give continuous film records of the stresses experienced at certain points. Three of these instruments were used to measure longitudinal stresses.

For comparison, a calculation was made of the stresses to be expected, and the broad conclusion reached from an analysis is as follows :—

The values of the calculated stresses relative to each other are fairly closely reproduced by the observed stress relative figures, but in absolute quantitative value the observed stresses are considerably less than the calculated values. A possible explanation of the reduced bending stresses is that the full extent of the bending which would result from the applied forces under static conditions is not attained under the rapidly changing dynamic conditions of the actual launch. In this connection it would seem that to reconcile the observed stress afloat with the calculated figure would require an initial stress of 1·6 tons per square inch tension on the promenade deck, which seems irrational, as any initial stress is more probably of a very small order.

In dealing with transverse bending, the fourth instrument was placed on the tank top to investigate the stresses on the transverse girder, which was taken as one frame space of the double bottom structure with a floor as web, and sell and tank top plating as flanges. The recorded and calculated stresses for the position chosen are shown in Table II.:

TABLE II.—*Record of Stresses Due to Longitudinal Bending.*

Tensile stress on tank top, tons/sq. in.

	Recorded.	Calculated.
Ship on berth	−0·18 to +0·05	0·09 with ways pressure = 2·0 tons/sq. ft.
At maximum way-end pressure position	0·92	0·33 with way-end pressure = 5·0 tons/sq. ft. 0·92 with way-end pressure = 18·1 tons/sq. ft.
Ship afloat	0·22	0·22

It will be seen that the calculated and recorded stresses for the ship on the berth and afloat are of roughly the same order, but that with the way-end pressure taken at 5 tons per square foot (for rigid conditions) the calculated stress is only about 36 per cent. of the observed value. To produce the observed stress a way-end pressure of 18·1 tons would be required, which agrees very closely with the calculated pressure value of 17·6 tons for elastic ways' conditions, to which reference has already been made, and justifies the internal shoring arrangements which were deemed so necessary.

It is satisfactory to record that the launch itself was accomplished without the slightest hitch or minor incident, and the vessel was safely secured in the fitting-out basin in 1 h. 15 min. A subsequent detailed examination of the structure, shoring and poppets, revealed no faults or signs of weakness of any kind.

The information given in this paper is presented in the hope that it may provide a basis for still greater advance in the science of launching. It is freely acknowledged that the calculations and observations recorded owe much to the data obtained in past experience, yet the magnitude of the operation involved many problems which were without precedent.

Canadian Engineering News.

(By our Canadian Correspondent.)

Business Expansion.

NOTWITHSTANDING the uncertainties which have prevailed, business in Canada is gradually improving. The customary contraction of employment at the close of last year was much smaller than usual, the contraction in factory employment being the smallest noted in any year since 1920. Of recent date there has been a marked increase in automobile production ; a production of electricity that is surpassing all records ; general activity in the production and shipment of primary metals and in forestry industries ; sharp gains in construction contracts, and external trade is at a higher level than a year ago. The Bank of Nova Scotia estimates there is 300,000,000 dollars' worth of residential construction awaiting a decisive change in business conditions. With the possible exception of agriculture, no other industry suffered during the depression like the construction industry. During 1921 to 1931 the average value annually of all construction contracts in Canada was slightly greater than 370,000,000 dollars. In 1933, which was the worst year since the war, less than 100,000,000 was spent on new construction contracts. The 1934 figures were only slightly above 125,000,000 dollars.

Large Steel Plant.

Construction of a 350,000-dollar steel plant will be started in Vancouver in the near future, by the Western Bridge Company, Ltd., on the site of the company's existing plant on False Creek. Establishment of the new plant is designed to manufacture all the steel work required for British Columbia and Alberta. At present the larger work is done in Hamilton, Ontario, at the plant of the Hamilton Bridge Company.

Process for Briquetting Peat.

A reported process of briquetting peat into a form of domestic fuel is being considered by the Canadian Department of Mines. Some years ago the Government made unsuccessful efforts to develop peat at Alfred, Ontario, spending nearly 400,000 dollars on the venture. Recently the Government was advised of a new process, which gives promise of success. In a statement in the House of Commons, the Minister of Mines said a representative of a British company had made some representations to the department and the matter was being given the closest study. He said the process was in use in Denmark and in Iceland.

New Equipment.

The Dominion Foundries and Steel, Ltd., Hamilton, Ontario, has installed additional equipment for the manufacture of hot rolled steel in coils and in flats up to 48in. in width. These are products not heretofore produced in Canada. This steel is largely used by automobile manufacturers, the hardware industry, and many other manufacturing plants in Canada. The company is also installing cold rolling equipment for the manufacture of tin-plate of the type used in the canning industry, in very large quantities. At present practically all of this tin-plate is imported. One of the largest mills in the Okanagan Valley, British Columbia, will be that of Oliver Sawmills, Ltd., Oliver, B.C., when expansion and remodelling operations are completed. Fifty tons of new machinery, including a gang saw capable of cutting thirty 1in. boards in one operation, is on order, and all the old machinery is being reconditioned. When the mill reopens it will have a minimum capacity of 40,000ft. of lumber a day and will be capable of turning out 2,000,000 fruit boxes per season.

A Sound Laboratory.

The National Research Council of Canada has established a new sound laboratory at Ottawa. The main room in this laboratory is known as the "reverberation chamber," wherein samples of materials are to be placed, reverberation measurements made, and from them absorption coefficients calculated. This chamber is of solid concrete (walls, floor, and ceiling), 1ft. thick, resting on an insulating base of cork and sand, which is designed to prevent extraneous noises from entering the chamber when it is in operation. Surrounding the chamber is a wall of 8in. cinder block, separated from the inner concrete room by a 12in. air space.

In addition to the reverberation chamber, there is an instrument room, where most of the apparatus is to be set up, and a "transmission" chamber. This room is of the same general construction as the larger reverberation chamber and opens into it through a system of massive doors. It is designed to be used in conjunction with the large chamber for measuring the sound insulating value of partitions. The partition under test will be built into the opening between the rooms, the doors kept open, and readings taken of the sound which gets through the partitions from one room to the other.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

BROWN BOVERI AND CO., Ltd., Baden, have received an order to install at the Oslo power station two oil-fired "Velox" generators, each having an output of 165,000 lb. per hour at 385 lb. per square inch g., 800 deg. Fah. superheat, supplying steam to a Brown Boveri single-cylinder steam turbo-alternator designed for an output of 30,000 kW.

STEWARTS AND LLOYDS, Ltd., and the British Mannesmann Tube Company, Ltd., acting in collaboration, have been successful in securing an important order from the Argentine Government Oilfields for oil well casing and other tubular requirements, the total value of the contract being approximately £250,000. The sizes of pipe involved vary from 24in. to 4in. diameter, and will be manufactured in the Glasgow and South Wales areas.

C. A. PARSONS AND CO., Ltd., of Newcastle-on-Tyne, have recently received from the Saskatchewan Power Commission an order for a geared turbo-alternator of 1500 kW capacity, complete with condensing plant, for the North Battleford power station in the Province of Saskatchewan. The turbine is to be of the pass-out type, driving the alternator at 1200 r.p.m. by means of reduction gearing. The unit will supply three-phase current at 2300 volts, and at the Canadian standard frequency of 60 cycles per second.

MIRRLEES, BICKERTON AND DAY, Ltd., Stockport, have recently received a number of orders, including one from the Pondicherry Municipality, India for a five-cylinder, 275 b.h.p., 300 r.p.m., airless injection "Mirrlees-Diesel" engine, to drive a B.T.H. generator ; and one from William Doxford and Sons, Ltd., Sunderland, for six two-cylinder, 120 b.h.p., 300 r.p.m. airless injection engines to drive "Sunderland Forge" dynamos for auxiliary generating sets on board three vessels which Messrs Doxfords are building.

THE CAMBRIDGE INSTRUMENT COMPANY, Ltd., of 45, Grosvenor-place, London, S.W.1, has received a contract for installations of electrical distance thermometers on the s.s. "Strathmore" and the s.s. "Orion." The outfits consist of the following instruments :—s.s. "Strathmore," one 72-point and one 36-point marine type indicator, with 94 heavy pattern resistance thermometers for air temperatures ; s.s. "Orion," one 24-point and one 48-point marine pattern indicator, with 59 heavy pattern water-tight air thermometers.

MERRYWEATHER AND SONS, Ltd., of Greenwich, have received from the Corporation of the County Borough of Grimsby an order for a motor turntable fire escape with all-steel ladder to reach a height of 100ft. The ladder will be equipped with life-saving apparatus, water tower monitor nozzle, and telephone apparatus. The machine will also be fitted with a fire pump capable of delivering 400 gallons per minute. The operation of the fire pump and all the movements of the ladder will be carried out by power from the petrol motor which propels the machine.

RICHARD DUNSTON, Ltd., Thorne, near Doncaster, has received an order from London owners for a single-screw, Diesel-engined tug. The vessel is intended for the towage of petrol-carrying barges on the river Thames, and has a length of 70ft. by 17ft. 6in. beam by 8ft. 6in. depth. The propelling machinery will consist of an Atlas Diesel engine, of British manufacture, capable of developing 390 b.h.p. at 300 r.p.m., together with an auxiliary engine and compressor. The tug will be constructed at the Hessle Yard, near Hull, of Henry Scarr, Ltd., Messrs. Dunstons' associated company.

BRITISH INSULATED CABLES, Ltd., of Prescot, Lancashire, has received from the Metropolitan-Vickers Electrical Company, Ltd., an order for the overhead equipment required in connection with the contract recently secured by that company for the electrification of the Central Railway of Brazil. The order is for the equipment of approximately 112 single track miles of track within the suburban section of the Central Railway of Brazil at Rio de Janeiro, and includes the overhead equipment of the track, with transmission lines to sub-stations and signal power supply, carried on track structures, together with all rail bonding.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., through its South African representatives, Wilson and Herd, Ltd., has received from the Electricity Supply Commission a large contract for mercury arc rectifiers for inverted operation to be used in connection with extensions to the electrification of the South African Railways. The order includes eighteen rectifiers, which are to be installed in nine sub-stations—four on the Cato Ridge-Durban section, and five on the Glencoe-Volksrust section. The incoming supply will be 88,000 volts, three-phase, 50 cycles, while the outgoing will be 3000 volts D.C. Each sub-station will include a step-down transformer with two secondary windings, each connected to a mercury arc rectifier. One rectifier will be arranged to supply power and the other arranged to return power to the A.C. system when the energy regenerated by the locomotives descending gradients exceeds the load demanded by other locomotives on the section. The two rectifiers will be so designed as to be interchangeable in function. Inverted operation of the rectifiers is effected by means of grid control ; grid control will also be used to maintain the sub-station voltage constant under varying load conditions. The contract also includes a large number of track high-speed circuit breakers.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Continental Steel Discussions.

The meeting between the British steel makers and the Steel Cartel, for which the whole steel trade has been waiting, appears to have come to a somewhat indefinite conclusion. According to available reports, the meeting adjourned to consider a final proposal of a quota of 643,000 tons of Continental steel for the British market and a reduction of the import duties to the level of 33⅓ per cent. existing before the recent increase. The British delegates, it is understood, will put the proposal before the Government, and another meeting with the Cartel is to take place in London on April 30th. After the debate in the House of Commons last week the Continental steel makers must have realised that the British industry has the support of the Government to a very full extent, and this may make it easier for terms to be arranged. The market appears to think that a tonnage quota for the British market in the neighbourhood of 650,000 tons should be acceptable to both sides; but with that point settled there will remain the difficulty of deciding upon the proportion of semis and the various kinds of finished materials which will be included in the total. It is said that at the Cannes meeting the British suggestions on this question did not meet with the approval of the Continental steel makers. The Continental refusal to agree to the British demand that all imported steel should pass through the hands of the British Iron and Steel Federation appears to have been recognised on the British side, and it seems likely that the existing Continental organisations in this country will supervise the distribution to the merchants and consumers. The important question of the British share in the export markets was probably discussed at Brussels. This will present some difficult problems, and is scarcely likely to be settled at the forthcoming meeting in London.

Iron and Steel Imports.

Considerable interest attaches to the figures given in the Board of Trade Returns for March relating to iron and steel imports, since these are the last returns under the old scale of duties which ceased on March 26th. As was only to be expected, anticipations that the duties would be increased led to an expansion in the quantities of iron and steel sent to this country, the total for March being 125,975 tons, compared with 103,306 tons in February. For the full quarter, however, the imports showed a decline when compared with the first three months of 1934, the totals being 359,787 tons and 364,849 tons respectively. Imports of pig iron showed a substantial increase to 12,606, against 7777 tons in February. Of the March total, 11,769 tons came from British India. Imports of blooms, billets, and slabs showed only a slight increase in March to 22,954 tons, against 20,732 tons in February. The largest quantity came from France, the total being 16,291 tons, Belgium being next with 4386 tons. On the quarter, however, there was a decrease to 74,922 tons this year from 87,982 tons for the corresponding period of 1934. The quantities of steel bars, rods, angles, shapes, and sections imported fell from 13,623 tons in February to 12,285 tons in March. Last month the largest quantity came from Belgium, the total being 8911 tons, Luxemburg coming next with 1551 tons, and Germany third with 1299 tons. The imports of these descriptions over the quarter, however, showed a large increase when compared with the corresponding period of last year, the figures being 44,572 tons, against 27,833 tons for 1934. The imports of girders, beams, joists, and pillars reached 6714 tons, a substantial decline from the total of 9640 tons imported in February. For the three months ending March 31st the quantity imported was 23,170 tons, against 26,828 tons in the first quarter of last year. An increase occurred in the imports of strip in March, which totalled 10,591 tons, against 4620 tons in the previous month. On the other hand, there was a noticeable decline on the figures for the quarter, which were 23,323 tons, compared with 35,503 tons in the corresponding period of last year. Belgium was the largest supplier of all kinds of iron and steel in March, the total amounting to 55,441 tons, France coming next with 22,986 tons, and Luxemburg next with 14,881 tons. Imports from Germany totalled 8732 tons.

Our Iron and Steel Exports.

The exports of iron and steel during March were maintained, generally speaking, and the total for the month shows an increase to 175,765 tons, against 172,941 tons in February; the latter, however, was a shorter month. Exports of pig iron declined from 9369 tons in February to 7045 tons in March, the figures for the full quarter being 27,639 tons, against 25,247 tons last year. The exports of steel bars, rods, angles, shapes, and sections totalled 14,732 tons in March, against 14,567 tons in February, the exports for the quarter, however, showing a substantial gain at 45,197 tons, compared with 31,989 for the corresponding period of last year. There was an increase in the exports of hoop and strip from 3577 tons to 4714 tons in March, whilst 11,644 tons were exported during the first three months of the year, against 10,633 tons in 1934. An increase is shown in the exports of plates and sheets not under ¼in. thick to 18,565 tons, against 16,941 tons in February, whilst the total for the quarter was 48,389 tons, compared with 40,428 tons for the first three months of last year. The quantity of plates and sheets under ¼in. thick exported last month totalled 11,137 tons, compared with 7543 tons in February. For the first three months of the year the exports were 31,439 tons, against 28,763 tons for the corresponding three months of 1934. Railway material was exported to the total of 11,299 tons, this being a sharp decline compared with the February figure of 15,510 tons. For the first quarter of this year the figures were 39,373 tons, compared with 23,128 tons in the corresponding period of 1934. The export of new rails in March reached 5201 tons, compared with 9097 tons in February, and for the quarter the totals were 23,003 tons and 13,821 tons for this year and 1934 respectively. Our best customer in March was India, with 24,303 tons, South Africa coming next with 18,648 tons and Australia third with 14,406 tons. Of foreign countries Argentine was first with 10,575 tons, Denmark second with 9864 tons, and Holland next with 6039 tons.

Pig Iron.

So far the April demand for pig iron has been disappointing. It is possible that the approach of the Easter holidays may have checked the normal seasonal increase in trade; but consumers' requirements seem to be either just maintained or rather less than a month ago. On the North-East Coast most of the business which has been transacted during the past week or two has consisted of small parcels, and consumers having running contracts seem in no hurry to renew them even in cases where they are approaching completion. Makers, however, view the situation with equanimity and appear confident that there will be a revival in demand when some of the unsettling political complications have been smoothed out. The blast-furnaces will not close down for the Easter holidays, and as specifications against contracts are likely to be upon a reduced scale, it is probable that there will be some addition to the stocks which, in recent weeks, have slightly increased. Scottish requirements of Cleveland pig iron are fairly well maintained, but an expansion in this trade is looked for. The price position in this market has improved and the ascertained average price for No. 3 Cleveland pig iron for the March quarter worked out at 58s. 3d. per ton, which compared with 57s. 4d. for the previous quarter. In two years the quarterly ascertainments have shown an increase of over 8s. per ton, and in spite of the wage increases and higher costs in the way of coke and ironstone, the industry must now be working on a profitable basis. Rather quiet conditions have ruled this week in the Midland pig iron market, and it seems to be generally recognised that the second quarter of the year has not opened favourably. The demand for foundry iron has been adversely affected by the slack conditions ruling at some of the light castings foundries, a number of which are working short time. The general impression is that stocks of Northamptonshire iron are growing, but that the accumulations of Derbyshire iron are heavier; but no doubt a moderate improvement in the market would be sufficient to restore the conditions obtaining in the industry in the earlier part of the year. The chief feature of the Scottish pig iron situation is the steadiness with which pig iron is moving to the consuming works. If production has not increased much, the demand at least has been well maintained. Business in hematite iron has been restricted of late, but this is probably only temporary, as there are large inquiries in circulation from South Wales and Midland consumers.

British Iron and Steel Production.

The monthly statement for March issued by the British Federation of Iron and Steel Manufacturers gives the production of pig iron as 553,200 tons, against 483,100 tons in February, and 503,600 tons in March of last year. The daily rate of output has increased in March to 17,845 tons, compared with 17,254 tons in February. The output of steel ingots and castings totalled 841,900 tons, the February figure being 769,500 tons, and for March last year 834,500 tons. The March production of pig iron included 137,000 tons of hematite, 285,000 tons of basic, 111,300 tons of foundry, and 11,500 tons of forge iron. At the end of the month ninety-seven furnaces were in operation, one having been blown out and one put into operation. The report does not give particulars, but the furnace blown out was at the works of John Lysaght, Ltd., Scunthorpe, Lincs., whilst one was put in by the Wellingboro' Iron Company, Ltd., Wellingborough. The following table shows the average monthly production of pig iron and steel over a period of years, and the output for the past four months:—

	Pig iron, tons.	Steel, tons.
1913—Monthly average	855,000 ..	638,600
1920 ,, ,, ...	669,500 ..	755,600
1929 ,, ,, ...	632,400 ..	803,000
1932 ,, ,, ...	297,800 ..	438,500
1933 ,, ,, ...	344,700 ..	585,300
1934 ,, ,, ...	498,200 ..	738,300
1934—December	513,500 ..	654,500
1935—January	521,200 ..	757,800
February	483,100 ..	769,500
March	553,200 ..	841,900

Scotland and the North.

The Scottish steel works are in a comfortable position as regards orders on their books, and are making heavy deliveries of plates and shipbuilding sections. During the past week there was a distinct lull in new business of a general character, but this was ascribed to the uncertainty created by the devaluation of the Belga and the inclination of consumers to await the outcome of the negotiations between the British and Continental steel manufacturers regarding a quota for the latter in the British market. Lately some new shipbuilding contracts have been placed for merchant vessels, and these were the more welcome since a considerable proportion of the work in the Clyde shipbuilders' hands is on Admiralty account, about half the Government's present naval programme having been placed with Scottish yards. The engineering industry on the whole is well employed, and is using considerable quantities of steel. The mills producing railway material had reached a stage when new business was badly needed, so that the orders placed by the London, Midland and Scottish Railway for 80,000 tons of rails were welcomed. The structural engineering shops in Scotland are well employed, and a large tonnage of this steel is passing into consumption. Although the re-rolling branches of the industry are better employed than in the early part of the year, they have not yet received the accession of business it was expected would follow an increase in the duties. These works, however, are not fully occupied, and are complaining of the competition they experience from works outside the Association. Business in sheets has been rather good during the past week or two, but this has been almost entirely upon home account. It is feared that the devaluation of the Belga will still further operate to the disadvantage of the Scottish makers in the export markets. In Lancashire the position at the finishing works is not unsatisfactory. Lately a number of fresh contracts have been booked by constructional engineers, but so far this business has not been reflected by any extensive orders for the steel works. There is an active demand for the lighter steel materials, and the re-rolling works are busy on the production of small bars and strip. This department seems to be obtaining some benefit from the higher duties.

Current Business.

The Egyptian State Railways have awarded a contract for boilers to the value of £3000 to Robert Stephenson and Co., Ltd., of Darlington. A contract for steel tires for the Glasgow Corporation tramways has been divided between John Baker and Bessemer, Ltd., of Sheffield, and the Steel Company of Scotland, Ltd., of Glasgow. Capper Pass and Son, Ltd., tin smelters and refiners, of Bristol, have decided to erect a new lead smelting works at Melton, near Brough, Yorks. General Sir Herbert Lawrence, in a speech at Barrow, stated that Vickers-Armstrongs, Ltd., were now employing over 30,000 people, compared with 24,600 a year ago. A. Reyrolle and Co., Ltd., Hebburn-on-Tyne, have decided to spend £20,000 on new plant. An order for a set of steam winding engines for the Government gold mining areas on the Rand has been secured by Joseph Foster and Sons, Ltd. (Successors to Yates and Thom, Ltd.), of Blackburn. Owing to the regulations issued by the Mexican Government, which render foreigners domiciled abroad liable to certain taxation in respect of income or profits, H.M. Consul-General recommends that British exporters should cease quoting in any other manner than ex factory or f.o.b. non-Mexican port. The Department of Overseas Trade announces that the following contracts are open for tender:—South African Railways and Harbours: forty-eight items of flat spring steel, two items tapered spring steel, four items of flat spring steel, 20 and 22 s.w.g.; and four items of round spring steel (Johannesburg, April 29th); high-pressure steam jointing in sheets 40in. by 40in. (Johannesburg, May 7th); structural steel work, including columns, purlins, roof trusses, galvanised gutters and down pipes, galvanised sheets, &c. (Johannesburg, May 27th); Durban Corporation: twenty-four tramcar axles (Durban, April 26th); Cape Town, Electricity Department: 200 30ft. and 600 27ft. tubular steel poles with buckle plates, eye-bolts, &c. (Cape Town, May 8th); Argentine, State Oilfields Directorate: four horizontal electrically welded or riveted cylindrical steel tanks for the storage of propane and butane (Buenos Aires, May 6th); 12,250 m. of seamless black steel tubes, nominal diameters ⅛in., ¼in., ⅜in., ½in., ¾in., 1¼in., 1½in., 3in., and 4in.; four double-acting pumps and two motor pumping sets (Buenos Aires, May 15th); Siam, Royal State Railways: ten copper firebox tube plates (Bangkok, May 17th).

Copper and Tin.

The activity in the electrolytic copper market has subsided somewhat, but this was only to be expected after the spell of buying which followed the agreement of the copper producers to restrict production. All markets purchased on a considerable scale, but Italian and German consumers who inquired for heavy tonnages were unable to satisfy all their requirements owing to difficulties regarding terms of payment. Suppliers have become rather nervous of the financial position in those countries in which foreign payments are controlled by Government Departments. It is realised that whilst the copper price has advanced with some rapidity it is possible that a reaction may take place and in that event, although private buyers may be quite willing to meet their obligations, Government Departments may place obstacles in the way of paying more than the current market price. In these circumstances many sellers have required payment before shipment. American consumers have bought heavily and in consequence there has been less copper sent to Europe by the producers. In fact, it is estimated that for April the American exports will not reach a total of 8000 tons, to which the American industry will be restricted after June 1st. In the standard market there has been a good deal of profit taking, but this was well absorbed and the price remained steady. Stocks of copper in Great Britain are now over 75,000 tons, but a large proportion is cathodes. . . . After a period of advancing prices in the tin market, partly due to the high prices ruling in the East, a slightly easier tone developed. Buying by consumers has been on a good scale, although American purchases did not fulfill anticipations. The Continent has shown more interest in the market and trading has been less spasmodic than for a long time. Heavy premiums are still being asked for special brands, up to £12 being quoted for spot Banca and £6 to £8 for Straits. Transactions in the London market have been on a comparatively small scale, and it is suggested that owing to the rigidity of the control exercised by the International Tin Committee the market is losing some of its importance. Since the control came into force speculators have been afraid to operate, and as much business is done by consumers direct with producers in the East there is less hedging against purchases.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only rom associated British Steelmakers: joists 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home. (*D/d Teesside Area*) £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	3 8 6	3 2 0
No. 1	3 9 0	3 2 6
Cleveland— (*D/d Teesside Area*)		
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 7 6	—
MIDLANDS—		
Staffs.— (*Delivered to Black Country Station*)		
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 12 6	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 7 6	—
N.W. COAST—		
Hematite Mixed Nos.	3 12 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
LANCS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. YORKS.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
MIDLANDS—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	7 5 0 to 7 15 0	—
SCOTLAND—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. COAST—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

LONDON AND THE SOUTH—	Home. £ s. d.	Export. £ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ⅜in.	9 10 0	8 5 0
„ 7/16in.	9 15 0	8 10 0
„ ½in.	9 10 0	8 5 0
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	8 5 0
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 7 6 .. 7 15 0 to	8 5 0

STEEL (*continued*).

GLASGOW AND DISTRICT—	Home. £ s. d.	Export. £ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 10 0	8 5 0

IRELAND—	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ⅜in.	9 10 0	9 12 6
„ 7/16in.	9 15 0	9 17 6
„ ½in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

Sheets.	Home. £ s. d.	Export. £ s. d.
10-G. to 13-G., f.o.r.	9 0 0	8 15 0
14-G. to 20-G., d/d	10 5 0	9 0 0
21-G. to 24-G., d/d	10 10 0	9 5 0
25-G. to 27-G., d/d	11 2 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £16 12s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.

20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2 to 19/2.

Tin-plate Bars, d/d South Wales Works, £5 7s. 6d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 tons	5 15 0
Rails, Heavy, 500-ton lots, f.o.t.	7 10 0
„ Light, f.o.t.	8 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 10 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·70 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/– to 5/3d. per lb.	

NON-FERROUS METALS.

Official Prices, April 17th.

COPPER—		
Cash	£31 3 9 to £31 6 3	
Three months	£31 12 6 to £31 13 9	
Electrolytic	£34 15 0 to £35 10 0	
Best Selected Ingots, d/d Birmingham	£35 15 0	
Sheets, Hot Rolled	£60 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	9¾d.	9¾d.
„ Brazed (basis)	9¾d.	9¾d.
BRASS—		
Ingots, 70/30, d/d Birmingham	£28 0 0 to £30 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9d.	9d.
„ Brazed	11d.	11½d.
TIN—		
Cash	£225 15 0 to £226 0 0	
Three months	£222 0 0 to £222 5 0	
LEAD	£12 10 0 to £12 15 0	
SPELTER	£13 2 6 to £13 7 6	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

LANARKSHIRE—	Export.
f.o.b. Grangemouth—Navigation Unscreened	13/– to 13/6
„ Glasgow–Ell	16/6
„ „ Splint	17/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/– to 14/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	13/6 to 14/–
Unscreened Navigation	12/6 to 13/–
LOTHIANS—	
(f.o.b. Leith)—Hartley Prime	13/6
Secondary Steam	13/–

ENGLAND.

YORKSHIRE, MANCHESTER—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	15/– to 17/6
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	13/9 to 14/–
„ Second	13/3
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 13/6
DURHAM—	
Best Gas	14/8
Foundry Coke	19/– to 20/–

SHEFFIELD—	Inland.
Best Hand-picked Branch	24/– to 26/–
South Yorkshire Best	21/– to 23/–
South Yorkshire Seconds	17/6 to 19/–
Rough Slacks	8/– to 9/–
Nutty Slacks	7/– to 8/6

SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	24/– to 37/6
Furnace Coke	19/– to 21/6
Patent Fuel	21/–
SWANSEA—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	41/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 22/6
Rubbly Culm	11/– to 11/6
Steam Coals:	
Large	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3¼d.
Diesel Oil	4d.

Manchester prices ¼d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

Franco-Belgian Barter.

In arranging with Belgium for goods imported from that country to be priced on the gold level that existed before the belga was devalued, it was agreed that some method should be devised of increasing exchanges without encroaching upon the debatable ground of the most-favoured-nation clause. There could be no question of giving preferential treatment which would have to be extended to other countries, and it appears that the French Government has fallen back upon the system of barter, which is claimed to have nothing of a discriminating character, for it is reported that in the commercial arrangement now being drawn up between the two countries Belgium will be allowed to export to France a certain quantity of metallurgical products and machinery to be paid for by wheat, which the French Government is anxious to dispose of in order to relieve the critical situation of the agricultural industry. In this case barter is an appellation that places reciprocal trading outside the scope of existing quotas. Whatever comes of this proposal, the fact of its being made is significant as showing that the necessities of agriculture are weakening the protection of metallurgical and engineering industries. Experience in this country has revealed that there can be no parallel prohibitive protection without one industry benefiting at the expense of another, and the lessons learned during the past two or three years may be expected to influence negotiations for a development of foreign trade when conditions allow of their being resumed. Meanwhile, trading by barter will give results that were aimed at by the French when they attempted to suppress the most-favoured-nation clause with the idea of making separate agreements on a strictly reciprocal basis, so that preferences could be accorded to countries that offered special advantages to French products. The effect of that policy would have been to maintain the idea of economic nationalism and place a definite limit to the development of foreign exchanges. As other countries will not accept a suppression of the most-favoured-nation clause it will be interesting to see whether the measures being examined by the French Government for giving satisfaction to Belgium will provide a practical basis for improved commercial relations with gold countries.

Colonial Transport.

The Economic Conference which has been investigating means of developing the overseas possessions and improving commercial relations between France and the colonies has completed its work, and amongst the matters discussed was the adoption of measures to ensure a monopoly of colonial traffic for French shipping. Practically, French shipowners already possess a monopoly so far as Africa is concerned, and foreign shipping carries only a small part of the total colonial freights. At the same time, the assistance rendered by the State to shipowners is regarded as insufficient in view of the higher charges imposed on shipping by social legislation, particularly the eight hours' day, which does not apply to foreign shipping, while the belief that the proposed economic unification of the French Empire will increase considerably the traffic urges shipowners to obtain a complete monopoly. The conference accepted the claims of shipowners and, while there can be no legal monopoly without causing international complications, it can, nevertheless, be made practically effective by recommendations that holders of colonial concessions shall be required to use French shipping exclusively and that independent shippers shall receive "compensating freight allowances" to make up for the difference between French and foreign freights. If means can be found to finance these compensating freight allowances shipowners will be relieved of foreign competition. The idea that all communications within the French Empire must be exclusively French will be carried out as far as possible.

Shipbuilding.

A deputation of mayors and others from the Saint-Nazaire district has waited on the President of the Council to urge the necessity of starting at once upon the construction of a second "Atlantique" liner in order to provide work at the shipyard. It is by no means certain that this can be done in view of the action which has been taken recently by the insurance underwriters. Having paid the money to the Compagnie Sud-Atlantique to avoid an accumulation of interest, they caused an investigation to be made on the burnt-out hull, which, it is alleged, revealed evidences of short circuiting through defective electrical wiring. They have now brought an action against the company on the ground that they have no liability. Until that case is heard and settled nothing can be done with the ship, which is to replace the destroyed liner. With only a few vessels of small tonnage in hand there is no alleviation of unemployment at the shipyards. Naval construction continues to provide work on a reduced scale, and there appears to be little hope of additional employment until the 35,000-ton battleship is put in hand. It is stated that the ship will have twelve guns of 340 mm. in three turrets aft. She will be begun in the dry construction dock at Brest after the "Dunkerque" has left in October next. As the dock is too short to allow of the hull being entirely completed it will be taken to another dock to be lengthened, as will be the case with the "Dunkerque."

A Bridge Collapse.

At the end of 1928 a suspension bridge across the Loire at Montjean, about 30 miles from Angers, was opened to traffic. Replacing an old bridge, the new structure had a reinforced concrete platform suspended from cables calculated with a margin to provide complete safety. The length of the bridge was 1502ft. On Friday last the bridge collapsed, about 500ft. of its length falling into the river through the breaking away, it is believed, of the cables at one end from their anchoring beds. At the time of writing the cables are being raised from the river for examination. There was no one on the bridge at the time it collapsed.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

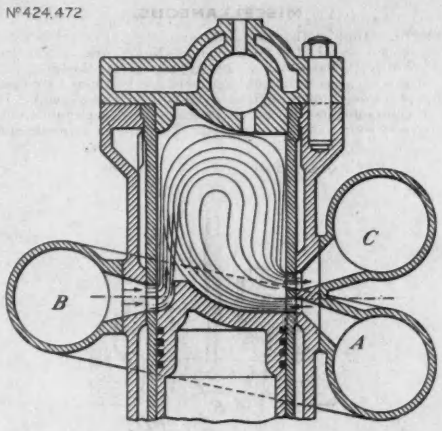
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

424,472. July 17th, 1934.—TWO-CYCLE ENGINES, H. K. Morén, Vasbergsgatan 1, Eskilstuna, Stockholm, Sweden.

In this engine the scavenging air is supplied through two ports A and B, and is directed across the top of the piston,

Nº 424,472

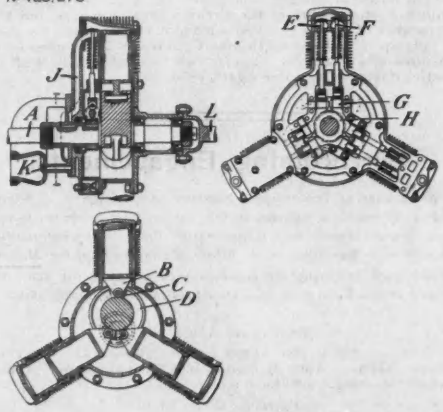


which is so shaped that the two jets of air combine and form a rising column on one side of the cylinder. This air is deflected downwards at the top and sweeps out of the cylinder on the opposite side through the exhaust ports C.—*February 21st*, 1935.

425,278. August 31st, 1934.—ROTARY ENGINES, J. Ferguson Edington, 67, Culzean-crescent, Kilmarnock.

In this engine the radial cylinder block rotates round a fixed shaft A. The pistons have extensions B, which are pinned to blocks C sliding in a groove D in a block on the end of the fixed

Nº 425,278



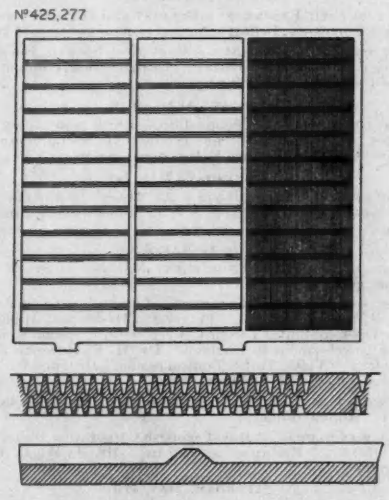
shaft. Each cylinder has an inlet and exhaust valve E and F operated by a cam shaft G, rotated by the fixed worm wheel H. Passages J provide communication between the inlet valves and the carburetter and between the exhaust valves and the exhaust manifold K. The propeller shaft is attached to the cylinder block at L.—*March 11th*, 1935.

BATTERIES AND ACCUMULATORS.

425,277. September 11th, 1933.—STORAGE BATTERIES, L. Ventrella, 35, Via Carlo Alberto, Turin, Italy.

The inventor aims to produce a storage battery with plates

Nº 425,277



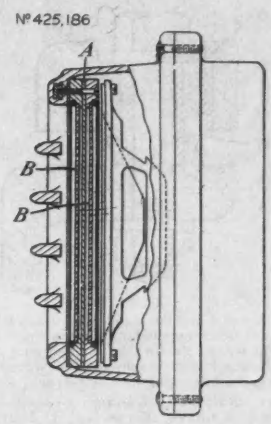
of the Planté type, so that it may be used for such services as the starters of motor car engines. The Planté plate has, of course, the advantage that it is robust, but is generally heavy in comparison with a plate of the pasted type. The plates, it will be seen, are of the ribbed type, and the essential feature is that the ribs should be from 0·2 mm. to 0·4 mm. thick, while the plate itself should be from 1 mm. to 3 mm. in thickness. The inventor states that such plates will withstand severe usage, and be no heavier than pasted plates.—*March 11th*, 1935.

TELEGRAPHS AND TELEPHONES.

425,186. November 24th, 1933.—TELEPHONE RECEIVERS, A. Graham and Co., Ltd., Caxton House, Tothill-street, Westminster, and C. H. Vaughan, 20, Cock Mannings-road, St. Mary Cray, Kent.

This receiver is designed to be impervious to moisture, and

Nº 425,186



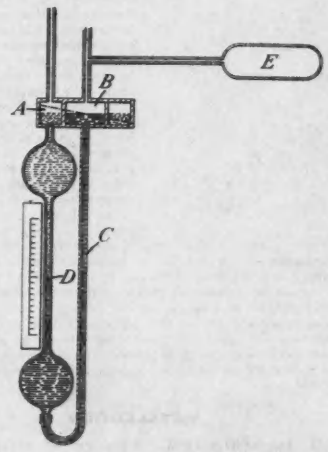
yet have good sound transmitting qualities. A diaphragm A of rubber or oiled silk is stretched across the opening to keep out the moisture, and is protected from being overstrained by perforated plates B B. These plates are of commercial zinc, which is not liable to be set in vibration by the sound waves produced by the receiver.—*March 8th*, 1935.

MEASURING AND TESTING INSTRUMENTS.

425,286. August 25th, 1933.—PRESSURE GAUGES, D. F. Dent, 4, Brick-court, Temple, London, E.C.4.

This micro-manometer is intended for use on gliders, to determine the rate of rise or fall and has the advantage that its readings are not affected by inclination. It comprises two chambers A and B, which are concentric. One is filled with a saturated solution of water in phenol, and the other with a saturated solution of phenol in water. The two chambers

Nº 425,286



are in communication with one another through the U tube C, which is of narrow bore. The position of the meniscus D, where the two fluids meet, is a measure of the pressure difference between the two chambers A and B. The chamber A is in direct communication with the atmosphere and the chamber B in communication with the thermos flask E and a leak-away to atmosphere. It will be seen that the inclination of the instrument, as indicated by the broken water line, does not affect the reading.—*February 25th*, 1935.

MINING MACHINERY.

425,203. June 20th, 1934.—ROCK DRILLS, Hardypick, Ltd., and P. T. Rayner, Heeley, Sheffield, 8.

The cutting tool or drill is given a rotary and reciprocating motion and is attached to the nose of the shaft A. This shaft

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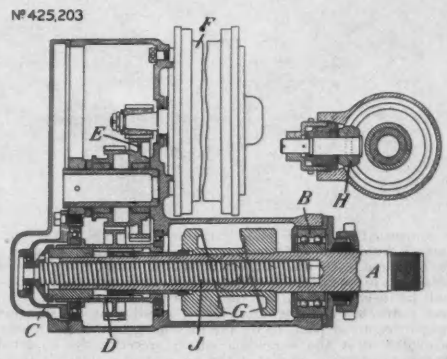


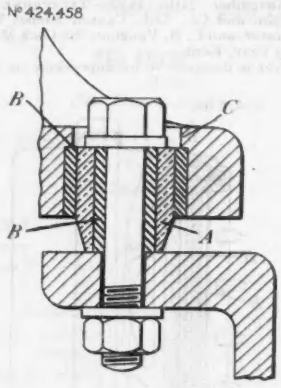
is mounted in a ball bearing B and a sleeve bearing C. Its rotary motion is provided by the splined sleeve D, which is driven through the gearing E by the electric motor F. The reciprocating motion is provided by the cam G, which engages with the roller H fixed to the casing. The spring J cushions the recoil.—*March 8th*, 1935.

MOTOR CARS AND ROAD TRAFFIC.

424,458. May 11th, 1934.—SHOCK ABSORBERS, Societa Italiana Pirelli, Via Fabio Filzi 21, Milan, Italy.

The essential feature of this rubber shock absorber is that it is encased with sleeves of ebonite, to which it is vulcanised, instead of being supported by metal ferrules. The rubber shock

Nº 424,458



absorber is shown at A and the ebonite sleeves at B B. The inner sleeve is clamped down by the holding-down bolt and the outer sleeve is caught by the flange C of the bedplate. The tapered extension of the shock absorber provides for a gradually increasing resistance to an increasing load.—*February 21st*, 1935.

424,469. July 12th, 1934.—EXHAUST SYSTEMS OF INTERNAL COMBUSTION ENGINES, E. Davies, 1, Harris-view, Penrhiwceiber, Glamorganshire.

We give the provisional specification verbatim:—"My invention relates to means intended to deal with motor fumes or motor exhaust that is released on the ground or floor, and to elevate such fumes to the uppermost point of a vehicle, car, or bus, that creates such fumes, and on that uppermost point release such fumes into the atmosphere by means of a perforated tube C D or pipe with end turned upwards. Pipes or tubes will be made of any metal. Pipe or tube will be made either in one length to take shape and height of car or bus, or made in short lengths. When made in short lengths, each end of short length will have a thread on, so that they can be connected together by means of a ferrule; such ferrule will have a thread on inside to screw pipes into, thus making a good joint. One end of pipe or tube will be bell-mouthed, as shown at B in accompanying drawing. Other end C will be perforated with holes, with open end turned upwards. The tube will be secured to any vehicle by means of bands and bolts and nuts. Pipe or tube will reach from bottom of car or bus, and will be taken up either side, back, or front of vehicle to top of such vehicle. Bell-mouth end B B will be placed over exhaust tube A. Exhaust tube A belongs to any car or bus, but is the point where exhaust is usually released into the atmosphere. When bell-mouth H is placed over exhaust pipe A, it tends to create a vacuum at F, and thus encourage a great flow of fresh air at mouth of bell-mouth B. Thus fumes exhausted at B are rushed up through tube and released at C D, and on top of car or bus fumes are diffused in small streams all across the vehicle that it will be fixed on. Application of my invention would free the streets of unpleasant and uncomfortable petrol exhaust fumes. Direction of fumes shown by arrow in accompanying drawings."—*February 21st*, 1935.

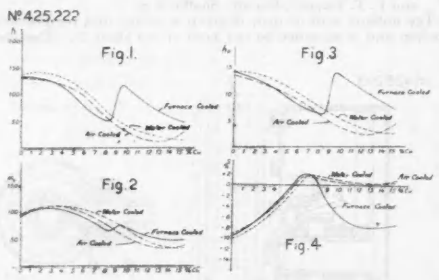
Nº 424,469

METALLURGY.

425,222. August 31st, 1933.—MAGNETIC MATERIALS, Allgemeine Elektricitäts-Gesellschaft, Friedrich Karl-Ufer 2/4, Berlin N.W.40, Germany.

This invention relates to a method for obtaining satisfactory values as regards stability of permeability, initial permeability, and hysteresis in a magnetic alloy of iron and nickel, with the possible additions of other materials of which copper is one, by annealing the material and finally working it in the cold so as to reduce its cross section. The technical value of these alloys proceeds from the fact that the expression $h_o = \frac{h}{\sqrt{\mu_o}}$, in which h is the hysteresis constant and μ_o represents the initial permeability, and which may be termed a factor of merit, could be reduced to values of from 6 down to 2. The present invention

Nº 425,222



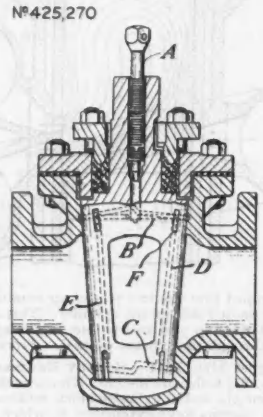
is concerned with basic magnetic alloys of nickel and iron containing from 30 to 70 per cent. of nickel to which copper has been added. It was hitherto thought that the properties possessed by such a material after cold working were dependent only on its constitution and the extent to which the cross section was reduced. The inventors have found that the magnetic properties are dependent on the manner in which the material is cooled after the annealing which precedes the final cold-working operation, and that the amount of copper in such an alloy is critical in the sense that, if more than this amount of copper is present, a lower value of the factor h_o is obtained if the alloy is cooled at least moderately rapidly after the aforesaid annealing than if it is cooled slowly. In addition, it has been found that the critical amount of copper depends on the amount of nickel in the basic nickel-iron alloy and rises as the amount of nickel increases. Thus, for example, in the case of an alloy in which the basic alloy contains about 36–40 per cent. nickel (i.e., 36–40 parts nickel to 64–60 parts iron), it is about 8 per cent.; in the case of one containing 50 per cent. nickel about 10 per cent., and in the case of one containing 65 per cent. nickel about 12 per cent. According to the present invention, therefore, a low value of the factor h_o is produced in a magnetic alloy containing 30 to 70 parts of nickel, 70 to 30 parts of iron, and an amount of copper greater than the aforesaid critical value by heating the alloy before the final cold-working operation to a temperature of 700 deg. Cent. or over, and cooling it from this temperature at least at a moderately rapid rate. Such a rate of cooling may, for example, be produced by allowing the material to cool in the air after removal from the furnace. The material may, however, alternatively be treated by quenching it from a temperature of at least 700 deg. possibly followed by reheating it at a temperature between about 350 deg. and 650 deg. Cent. Figs. 1–4 illustrate the relationship between hysteresis constant, initial permeability, the factor h_o and instability respectively and speed of cooling, and percentage of copper, in the case of a basic alloy of 36 parts nickel and 64 parts iron.—*February 28th*, 1935.

MISCELLANEOUS.

425,270. June 25th, 1934.—LUBRICATING PLUG COCKS, F. H. Morehead, 15, Park-avenue, New York, U.S.A., and Walworth Patents Inc., 28, Albany-street, Boston.

In this plug cock the rubbing faces are lubricated by means of grease forced in through an axial hole by the screw A. This hole communicates by radial passages with a circumferential groove B round the plug seating. This groove is made spiral

Nº 425,270



to prevent it cutting the seating as the plug is ground in. Another circumferential groove C at the bottom is in communication by means of a longitudinal groove D. A second longitudinal groove E stops short of the circumferential grooves, but the framework of grease grooves is made complete when the cock is fully open or closed by the short grooves F. The pressure of the grease beneath the plug can then be used to jack it off its seating if it is stuck.—*March 11th*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

THURSDAY, APRIL 25TH.

INST. OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOC.—James Watt Memorial Inst., Birmingham. Annual general meeting. 5.30 for 6 p.m.

FRIDAY, APRIL 26TH.

CHEMICAL ENGINEERING GROUP.—At Waldorf Hotel, Aldwych, W.C.2. Annual general meeting, 6.45 p.m. Annual dinner, 7.15 for 7.30 p.m. After dinner, address, "A Historical Survey of Wage Adjustments," the Rt. Hon. Lord Amulree.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS.—Savoy-place, W.C.2. Informal discussion. 6.30 for 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Informal meeting. General discussion on "Engineering Topics." 7.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—At Mining Inst., Newcastle-upon-Tyne. "Ship Collisions," Mr. H. E. J. Camps. 6 p.m.

MONDAY, APRIL 29TH.

INST. OF CIVIL ENGINEERS: BELFAST AND DISTRICT ASSOC.—Queen's University, Belfast. Annual general meeting. 6.30 p.m.

SOC. OF ENGINEERS.—At the Geological Society, Burlington House, W.1. "Modern Methods of Engineering Training," Dr. Herbert Schofield. 5.30 for 6 p.m.

TUESDAY, APRIL 30TH.

INST. OF FUEL.—At Chemical Soc., Burlington House, W.1. "Paper dealing with "The Production of Comparatively Ash-free Coal," M. Maurice F. Bertrand. 6 p.m.

WEDNESDAY, MAY 1ST.

SOC. OF GLASS TECHNOLOGY.—At Messrs. Holophane, Ltd., Elverton-street, Westminster, S.W.1. London Section meeting. 7.30 p.m.

FRIDAY, MAY 3RD.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN STUDENTS.—Annual general meeting.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Discussion, "Progress in Design and Application of the Lysholm-Smith Torque Converter, with Special Reference to the Development in England," Dr. H. F. Haworth and A. Lysholm; "Voith Turbo Transmissions," Dr.-Ing. W. Hahn, translated by Mr. H. Sinclair. 6 p.m.

JUNIOR INST. OF ENGINEERS.—Hotel Metropole, London, S.W.1. Annual dinner.

RAILWAY CLUB.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. "Railways in the Air," Mr. J. W. C. Logan. 7.30 p.m.

SATURDAY, MAY 4TH.

INST. OF ELECTRICAL ENGINEERS: METER AND INSTRUMENT SECTION. Visit to Electrical Laboratories of Queen Mary College, Mile End-road, E. Leave I.E.E. Building, Savoy-place, W.C.2, 9.30 a.m. Leave Tower Pier at 1.30 p.m. for river trip to Greenwich.

SUNDAY, MAY 5TH.

ROYAL AERONAUTICAL SOC.—At Mr. Fairey's Aerodrome, Heath Row. Garden party. 2 to 7 p.m.

WEDNESDAY, MAY 8TH.

INST. OF METALS.—At the Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Twenty-fifth annual May Lecture. "Atomic Arrangements in Metals and Alloys," Prof. W. L. Bragg, F.R.S. 8 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Canals," Mr. W. H. Curtis. 8 p.m.

WEDNESDAY, MAY 8TH, TO SATURDAY, MAY 11TH.

INST. OF STRUCTURAL ENGINEERS.—Institution Conference in London.

FRIDAY, MAY 10TH.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—In Hall of the School of Economics and Commerce, Bell-street, Dundee. The Faraday Lecture, "Electricity in the Life of To-day," Prof. E. W. Marchant. 7.30 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Mr. John Holloway will introduce discussion on "Machine Tools: Twenty-five Years' Development Demonstrated at the Recent Machine Tools Exhibition." 7 p.m.

SATURDAY, MAY 11TH.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Excursion from Dundee to Taymouth Castle Hotel *vid* Dunkeld and Aberfeldy. Leave Albert-square, Dundee, 9.15 a.m.

WEDNESDAY, MAY 15TH.

INST. OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—Visit to Droitwich Broadcasting Station. 3 p.m.

THURSDAY, MAY 16TH.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "The Evolution of the Industrial System in the Far East," Prof. A. F. Barker. The paper will be read by Prof. A. T. King. 8 p.m.

MONDAY TO FRIDAY, MAY 20TH TO 31ST.

BRITISH INDUSTRIES FAIR: ENGINEERING AND HARDWARE SECTIONS.—Castle Bromwich, Birmingham. Daily except Sunday.

WEDNESDAY, MAY 22ND.

INST. OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—Visit to Droitwich Broadcasting Station. 3 p.m.

THURSDAY, MAY 30TH.

ROYAL AERONAUTICAL SOC.—In the Science Museum, South Kensington, S.W.7. Wilbur Wright Memorial Lecture and Conversazione. The Memorial Lecture will be read by Mr. D. W. Douglas. 9 p.m. to 12 midnight.

TUESDAY, JUNE 25TH, TO SATURDAY, JUNE 29TH.

BRITISH WATERWORKS ASSOC.—Summer Meeting at Cambridge. For provisional programme see page 382, April 12th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THOS. W. WARD, Ltd., of Sheffield, has acquired the Nottingham factory of Metropolitan-Cammell Carriage and Wagon Company, covering about 13 acres.

MR. B. WELBOURN, chief engineer of British Insulated Cables, Ltd., is to receive the degree (honorary) of Master of Engineering from Liverpool University at the graduation ceremony to be held on July 6th.

DANIEL ADAMSON AND CO., Ltd., Dukinfield, announce that they have recently acquired the services of Mr. D. T. Sloan to assist their managing director, Mr. Percy A. W. Parkyn. Mr. Sloan served his apprenticeship in the chief mechanical engineer's department of the Lancashire and Yorkshire Railway Company, and was recently a director of Joseph Foster and Sons, Ltd., and Yates and Thom, of Preston and Blackburn.

THE STANTON IRONWORKS COMPANY, Ltd., which is the exclusive licensee under the De Lavaud patents, has sub-licensed Cochranes (Middlesbro') Foundry, Ltd., to manufacture its centrifugal pipes under the De Lavaud patents for five years commencing January 1st, 1935. In view of this fact, the International de Lavaud Manufacturing Corporation has withdrawn its threat of action against the Cochrane Company. It will be recalled that the Cochrane Company is the exclusive licensee in this country under the Mairy patents. The Cochrane Company has sub-licensed the Stanton Company to use the Mairy process in conjunction with the De Lavaud system. It follows from the above that the Stanton and Cochrane companies will in future be making similar pipes, and that each will be working under both the De Lavaud and Mairy patents.

A NEW HOUSE JOURNAL.—We have received from Charles Churchill and Co., Ltd., Albert-street, Birmingham, a copy of the first issue of their new house journal. Published with a view to bringing the firm and its friends more closely together on subjects of common interest, the book, which is to appear periodically, will also be used to place at the disposal of others the firm's knowledge of engineering subjects accumulated during the seventy-five years of its existence. The journal is well printed and illustrated, and although it naturally deals with the products and processes of one firm, is very interesting.

THE INSTITUTION OF ENGINEERS IN CHARGE.—The thirty-fifth annual dinner of the Institution of Engineers in Charge was held at the Holborn Restaurant on Friday, April 12th, and appeared to be, if anything, more largely attended than usual. Mr. E. A. Sandford Fawcett, the President, occupied the chair, with Mr. C. W. Dawe, Chairman of the Institution, as Vice-Chairman. At the top table there were many notable engineers, and at least a dozen institutions were represented. The toast of the evening was proposed by Dr. H. Levinstein in a light speech, and was acknowledged by the President in a serious one, which ultimately developed into gentle raillery of the institutions. Mr. W. Reavell, remembering that this year sees the centenary of Local Government, gave an outline of the history of civic and borough corporations, when proposing "Our Government and Municipal Services." To his speech, Mr. R. G. Hetherington, Chief Engineering Inspector, Ministry of Health, and Mr. T. Pierson Frank, Chief Engineer and County Surveyor, London County Council, responded in terms becoming the offices which they hold. Then Lieut.-Colonel J. D. K. Restler, Immediate Past-President of the Institution, proposed "The Guests," and Major W. W. Grantham, Deputy Chairman, London County Council, in response, made the most novel and effective speech of the season. He took from his pocket a light silver chain to which there were attached three coloured discs. Hanging the chain over the microphone standard, he called the attention of the diners to the fact that the green disc was showing. That meant "go." Pulling slowly on the chain he hauled the next disc, a yellow one, for "warning" into position, and without pausing exposed the final disc, which, he said, meant "stop," and so he sat down. Mr. C. W. Dawe then gave the toast of "The Chairman," which was received with the usual heartiness. An excellent musical and entertaining programme was somewhat spoiled by an echo effect which seemed to be due to the loudspeakers. If the operators of these devices would handle them with more discretion their qualities would not be so often marred.